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THE UNION ELECTRIC SEMAPHORE SIGNAL.

THE accompanying engravings illustrate the mechanism and electric connections of a very effective automatic system of railway semaphore signals. The signal blades in this system are operated by means of a small electric motor. Reference to the sectional view will assist us in understanding the mechanism employed. This illustration shows the construction used in operating a two-blade signal, one blade for indicating "home danger," and the other for "distant danger" or "caution." The two blades are similarly operated by means of levers called "slot-arms." The slot arm shown in section is illustrated as occupying a position indicating safety. This position is attained in the following manner. The motor when the current is turned on, drives two endless sprocket chains through the medium of step-down gearing. These chains travel vertically, passing over idlers at the top of the frame. One of the chain link pins on each chain is extended to give bearing for a pair of rollers. The slot-arm above referred to is pivoted at the right of the mechanism, and is provided with a forked finger which lies in the path of these rollers. This finger is connected through a system of levers to the armature of a "slot-magnet" carried by the slot-arm. When current flows through this magnet the armature is attracted and locks the levers and finger in the rigid position shown. When thus held the arm is lifted by the roller trunnions on the chain to its upper position shown, where a latch depending from the upper framework engages the pins which project from the side faces of the finger. At the same time a lug on the slot-arm serves to open the circuit breaker at the top of the frame, cutting off the current from the motor, which, under action of an automatic brake is almost immediately stopped. However, current is still supplied to the slot magnet through a separate contact formed by action of the slot-arm. The slot-arm in rising to its upper position turns the semaphore blade to "safety," and thus the parts are held as long as the slot-magnet is energized. But as soon as the magnetic field is destroyed, the armature is released and the finger being free to swing on its pivot, slides out of engagement with the latch, permitting the slot-arm to drop to its lowest position. A buffer at the right of the mechanism serves to take up all shock occasioned by the counter-weight in falling.

The diagram shows the electrical connections by which both the "home" and "caution" signals are operated without the use of line wires. Each track circuit includes the magnet of a relay having a "neutral" and "polar" armature which control respectively the home and distant arms of the signal marking the entrance of the block whose rails form the track circuit. Normally, when all the blocks are occupied, and when all switches therein are properly set for main line traffic, signals indicate the fact by displaying "safety." The movement of the switch from the main line or the presence of a train within the block, short circuits the relay and thus depriving it of current energy, causes the neutral armature to drop and to open the circuit of the signals which immediately assume a horizontal position by gravity. Each home signal is fitted with a pole-changing device which, as the signal moves to danger, changes the direction of the current in the track circuit preceding it and causes the polar armature of the relay at the other end of the circuit to shift and open the circuit of the distant signal there located, whereupon this signal assumes the caution position in the manner previously described. In non-polarized systems two line-wires are required between each home and its distant signal for the control of the latter by the former, the rails of the block section controlling the home signals only by non-polarized relays and track circuits of constant current direction.

The reversal of the track circuit in this system besides causing the shifting of the polar armature of the relay, ca ses an instantaneous release and return of the neutral armature also. The momentary interruption of the home signal circuit thus produced would cause it, from the nature of the mechanism holding the signal at safety, to assume danger, were it controlled directly by the neutral armature of this relay. Instead the home signal is controlled by means of an intermediate relay of special design, having sufficient self-induction to cause a slow release of its armature when the current controlling it is interrupted. As before stated this interruption covers but a moment of time during the reversal of current in the track circuit, and therefore has no effect upon the home signal.

The battery employed in operating and controlling the signal consists preferably of sixteen cells of caustic potash battery. When in clear position the magnets of the signal slots, and that of the slow releasing relay, all of which are normally in parallel circuit with the battery, entail the total current discharge of 0.016 ampere. The current drawn from these cells during motor operation is slightly under two amperes, allowing for the initial discharge occurring at the instant that the motor starts and before its counter E.M.F. is developed. Were the batteries employed solely for the purpose of holding the signals at safety, and not for their operation as well, the current discharged from the cells would represent 0.384 ampere hour daily. As the cells have a capacity of 300 ampere hours they should for this purpose alone, last over two years without renewals. Assuming

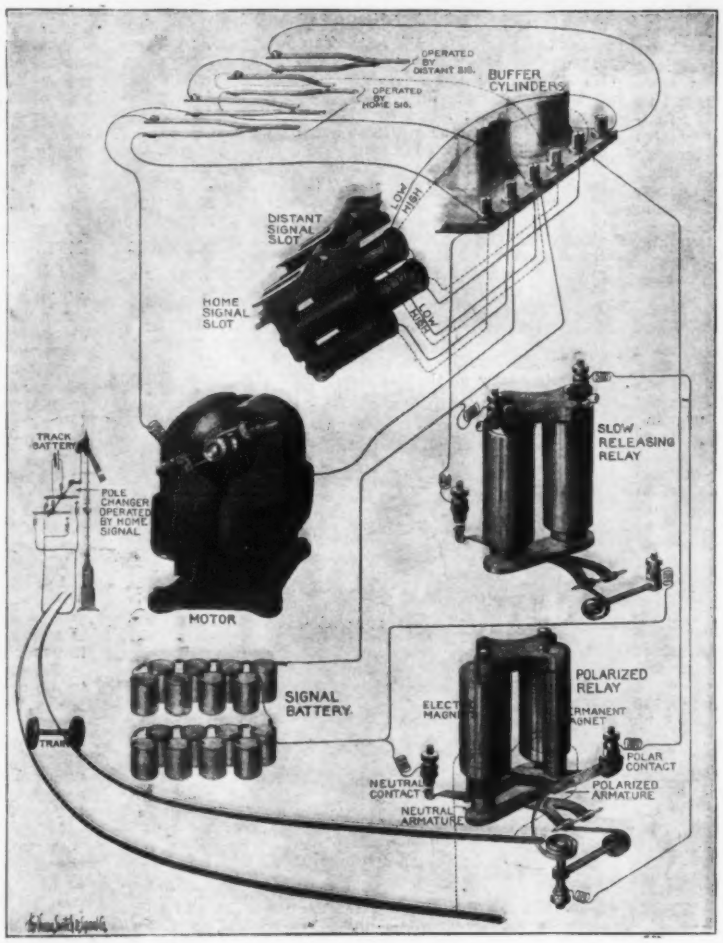
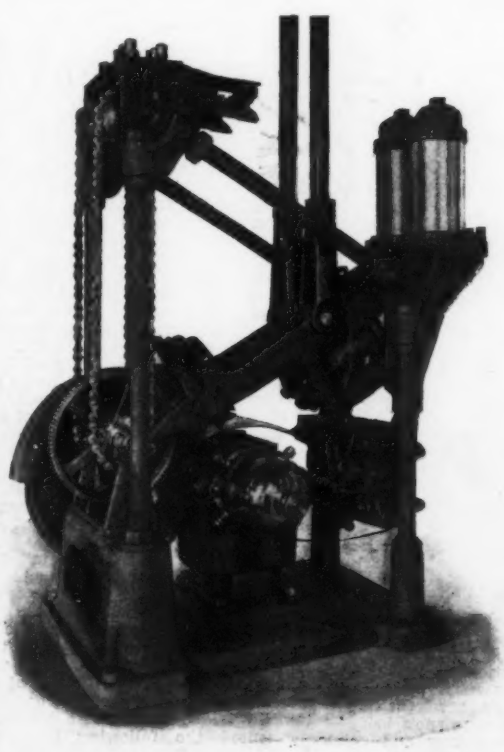
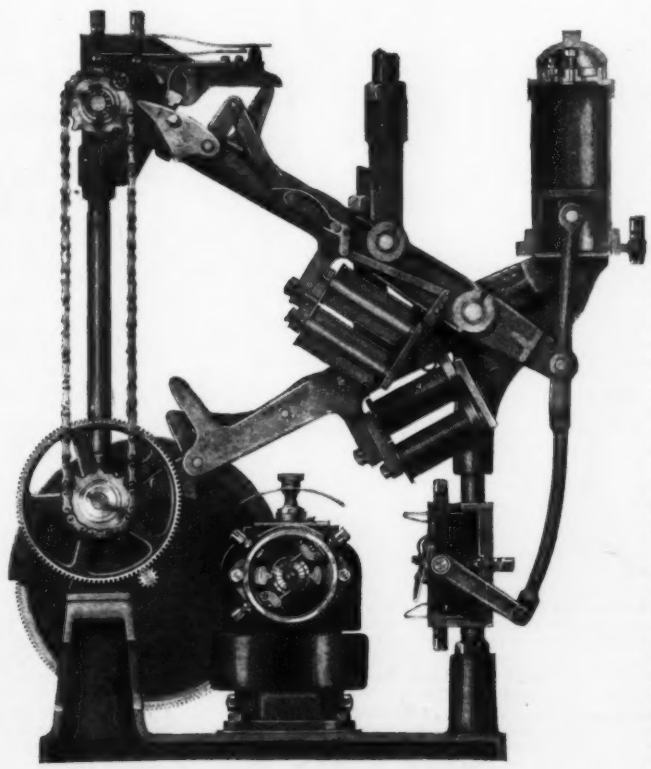


DIAGRAM ILLUSTRATING POLARIZED TRACK CIRCUIT SYSTEM.



GENERAL VIEW OF THE MECHANISM.



SECTIONAL VIEW THROUGH THE SLOT ARM.

THE UNION ELECTRIC SEMAPHORE SIGNAL.

that the traffic of the road is represented by sixty trains daily, and hence sixty operations of the home distance signals at the entrance of each block, it is estimated that the battery would be serviceable for practically a year. The energy of the batteries is drawn so moderately and under such favorable conditions that they are never overtaxed until their full rated capacity for work has been reached.

One of our illustrations shows the special form of motor used which is provided with a field-actuated brake tending to overcome the momentum of the armature when the current is cut off. The commutator is covered by a transparent shield which overcomes the serious troubles formerly experienced from frost or dust accumulating on the commutator.

To insure the economy resulting from high resistance in slot magnets and to render them capable of performing their duty during motor operations, they are compound wound. The inner or primary winding is of high resistance and energizes the magnets under normal conditions when battery E.M.F. is highest. The outer or secondary winding consists of a relatively few convolutions of low resistance and is included in the motor circuit. The loss in energy caused by the fall in E.M.F. at the terminals of the primary winding during the motor operation is thus compensated for by the influence of the motor circuit in the secondary winding of the magnets. It is this feature of the signal which renders one set of batteries thoroughly practicable as a common source of energy for its operation as well as for its control, and which by the unifying elements and concentrating energy, makes its maintenance and inspection both simple and economical of performance.

These signals are made by the Union Switch and Signal Co., of Swissvale, Pa.

LITHOPONE.

The only white metallic substances capable of competing with white lead are the whites of zinc base. There are two, the oxide and the sulphide. Zinc oxide, as known for a long time, is employed in certain special works, but this employment is limited by two serious inconveniences, (1) its slight covering power, (2) its high price. The sulphide of zinc covers well enough, but it is expensive. It would therefore be rejected, if, by means of complicated chemical processes based on the double decomposition of barium sulphide and zinc sulphate, it were not mixed intimately and in definite proportions with the sulphate of baryta. This mixture, it may almost be called combination, yields the product known in industry under the name of lithopone.

This product, which dates from 1874, and which the English, who were first to manufacture it, denominated Charlton white, did not have much success during the first twenty years, because its manufacture was difficult, and notwithstanding the apparent simplicity of the formula, yielded a product of slight covering power and at a high price. It was in 1890 and especially in 1895, that lithopone, perfected by the Germans, entered on a large development. There are now consumed in France and abroad 30,000,000 or 40,000,000 of kilogrammes per year. The campaign, conducted by the public authorities and the health committees against white lead, has contributed to the success of lithopone. This opposition is likely to increase, and white lead will probably be replaced by lithopone in most works of painting.

Lithopone can be employed advantageously on account of its whiteness and covering power; and, like white lead, it is resistant to the changes of the weather. It is not blackened by sulphurous emanations, and is perfectly harmless. Its price is 15 to 20 per cent less than that of pure white lead.

Still it has a deadly enemy, bad production; many people imagine that, on account of the simplicity of the formula, lithopone can be manufactured by simply mixing natural sulphate of baryta with zinc sulphide, or even zinc oxide. This is a great error. The product thus obtained cannot be compared with the lithopone produced chemically, requiring complicated processes and large and costly factories. We advise those who wish to try lithopone to procure it directly from Germany or from French importers of the highest class, while awaiting its industrial manufacture in France. —La Nature.

HOW SOAP IS COLORED.

By F. A. Emmel.

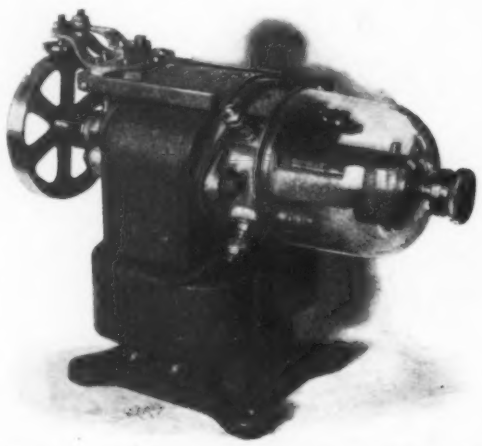
The buyer of soaps desires not only that the quality and the scent of the article be pleasing to him; he has also a preference for colors, and purchases rather an inferior soap for a good price as an excellent whitish-yellow substance of great purity. This is the reason why the manufacturers are always so eager to add an agreeable appearance to the other qualities of the article. To mention all the coloring materials for soap is not possible, they are too numerous, but there is a curious point between them; the materials which color soap very easily are at the same time very expensive, and for that reason, excluded from the production of the middle and lower qualities; they are only employed in the manufacture of the best article.

Metallic oxides have taken the place of cochineal, and aniline colors compete with plainer substances to produce a red color, which was formerly made exclusively out of the natural substance, which had to be substituted on account of costliness. The general employment of the metallic oxides has its only advantage in the decreased cost; their employment is much more difficult, and their specific gravity is very high, which results in a bad homogeneous impregnation in case it is used for incorporation in a mass of soap which is too liquid; in these cases the metallic oxides settle down in the lower strata, just like sediments in oil. For this reason, the compound of the soap has to be brought to a sufficient firmness and consistency, preventing the color from settling in one stratum. Mineral colors cause also opacity, and can, for this reason, not be employed for making transparent soaps.

It is necessary to grind the oxides as fine as possible; the powder must contain no hard grains, which unsettle the soap. The metallic oxide colors are permanent, and last an indefinite time, an advantage which is not held by aniline colors, which are sometimes substituted for these. It is therefore curious to note how, in spite of these disadvantages, coal-tar dyes have been advancing in the universal use of soap-production, and it looks as if the tendency was to supplant all mineral by aniline dyes in the coloring of soaps. The sensitiveness of the latter coloring materials to light are a great inconvenience, and this drawback can only be forgotten by the beautiful and excellent results which can only be achieved by their employment. It is a further bad point for aniline dyes that they are often destroyed and nearly always affected by alkalies; only few of the compounds can withstand the influence of a small excess of base, and these can be used with the full assurance of success.

The production of colors for soap-makers has been made a specialty by several dye manufacturers, who make color compounds which can be used by all soap-boilers without difficulty. The color substances are dissolved in boiling water and then added to the soap, when the mixture must be well stirred up. A few of these color compounds need mixing with a little oil previous to their addition to the soap substance. A pharmaceutical expert gave recently in our contemporary, La Parfumerie et Savonnerie Française, the following list of color materials mostly employed in the manufacture of soap:

Fuchsine has taken the place of cochineal on account of finer color effects and a much cheaper price; a small quantity suffices to give a fine and effective shade. Only very little quantities of this dye must be used, otherwise the soap stains other materials it comes into contact with, or for the washing of which it has been employed. Opaque soaps use always aniline red, sometimes also mineral colors, as vermilion, chrome red, and iron-oxide. Phthalein dyes give very delicate and excellent shades of colors, such as are known as eosine, Bengal rose, and rhodamine, and these three are also to be preferred. When these colors are dissolved in a liquid, they show great fluorescence, a fact known to those who handle the material, and this is another point in favor of the product. As stated before, it is not possible to use mineral dyes for the coloring of



MOTOR USED, SHOWING TRANSPARENT SHIELD OVER COMMUTATOR.

transparent soaps, and in these cases, the phthalein dyes enter a particularly suitable field.

Vermilion gives a most brilliant color, only the material costs such an excessive price, for which reason it is no wonder that chrome red, a chromate of lead, has found such great favor, and is used everywhere as a substitute for vermilion. Only the chrome red becomes black as soon as it is placed in an atmosphere which has only the smallest traces of sulphureted hydrogen, and, for this reason, it cannot be called a suitable material for soap-makers. Colcotar (coicothar), or oxide of iron, an article which has also many other names, is much used for the cheaper kinds of soap, and it proves for this purpose fairly effective. Yellow anilines mostly in use are made of yellow naphthol and picric acid, and these colors, which, in combination with fuchsine, give excellent orange shades, can also be highly recommended. It would be more advisable to add a little raw palm oil instead of the small quantities of fuchsine, were it not that no fixed color can be obtained by the addition of the substance, which is a serious drawback.

Chrome yellow, like the mineral yellow, would find frequent employment, but the influence of sulphureted hydrogen turns the mixed substances to a blackish color. Ocher is also used for the yellow coloring of soap; it dyes the soap yellow when used in its natural state; but if used after calcination, the color effect is orange, and very agreeable. There is a considerable number of other yellow colors, of which some are natural, and the others artificial. The former class includes dyes like caramel, curcuma, and saffron; the last-mentioned finds only very occasional use, on account of its high price, which makes it too expensive for all but exceptional cases.—Oils, Colours and Drysalteries.

PROFESSOR LANGLEY'S BOLOMETER.

A prismatic spectrum is formed by a spectroscope of the so-called "fixed arm type," in which, as the reader will recall, the ray which is in minimum deviation is given a certain fixed direction by an optical method, so that the observing instrument remains fixed also. This observing instrument is here the bolometer, whose essential part is a Wheatstone's bridge, chiefly formed of two excessively narrow and thin strips of platinum, only one of which is exposed to the radiation to be studied. On looking into the eyepiece of the bolometer, this appears like a single spider web wire of a micrometer, seen against the background of the spectrum, for instance just below the *A* line, whose position might be read by it on the large azimuth circle on which the bolometer is mounted. But this thread is not alone a fiducial index, for since it conveys an electric current it is also sensitive and comparable to a nerve which will recognize the heat or cold which falls on it, and not only recognize but accurately measure it by the changes set up in the current in question.

The whole forms an electrical thermometer which actually measures to very much less than the millionth of a degree.

As the bolometer strip is warmed or cooled, the galvanometer mirror turns to and fro, and the spot of light which it reflects passes to and fro on its scale, which is here a photographic plate. A clockwork of extreme accuracy moves the rock salt prism so that the spectrum marches uniformly across the bolometer thread at a rate, let us say, of one minute of arc in one minute of time, while the photographic plate moves as regularly in a vertical direction at right angles to the movements of the galvanometer spot at a rate, for example, of a centimeter in one minute of time. There is thus produced a curve called a bolograph, in which ordinates accurately correspond to relative amounts of energy, and abscissæ to deviations in the prismatic spectrum. Depressions in this curve correspond to cooler lines or bands in the spectrum; the visible Fraunhofer lines, which are cool to the bolometer, appear as such deflections in the bolographs; the invisible lines, which are wholly insensible to the eye and chiefly insensible to the photographic plate, but which are recognized everywhere by the bolometer and discovered to fill the whole infra-red, are recorded also.—Prof. S. P. Langley, in the Monthly Weather Review.

INFLUENCE OF THE ACADÉMIE DES SCIENCES ON IMPROVEMENTS IN MEASURING TIME.

The Académie des Sciences, from its origin, did not confine itself to protecting the study of the sciences. The mechanical arts were also the object of its encouragement, as may be seen from the number of machines and inventions described in its memoirs, in which horology occupies a distinguished place.

This encouragement assumed a more decided character when the academy came into possession of a fund proceeding from the legacy of M. Rouillé de Mesley, counselor of the Parliament of Paris, the fund to be employed in founding prizes for the improvement of the sciences, the art of navigation and the determination of longitudes at sea.

Horology was not forgotten in its different programmes.

The academy came into possession of this legacy on the 30th of May, 1718, and put in competition for the prize of 1720 the following programme: What is the best method of observing at sea the equality of movement of a pendulum, either by the construction of the machine or by its suspension?

The prize, of the value of 1,500 livres, was awarded to the memoir of a clockmaker of the name of Nicholas Massy. Our readers may be interested in the prominent point of this memoir: "When it is considered that the principal cause of the variations of a watch proceeds from the changes of temperature that it undergoes, it is advantageous to make use of as good a watch as possible and to maintain it at constant temperature."

This counsel was easy enough to give, but not very easy to follow. The author needed to communicate the means of securing this constancy of temperature, and if he did not, it was because he could not.

We, therefore, remark that the academy, in awarding the prize to Massy, manifested great generosity. In fact, all the prizes, down to the competition of 1769 and 1773, were awarded with the same indulgence.

The academy, for the prize of 1725, announced the following programme: The best method of preserving at sea the equality of the movement of clepsydras and sand-glasses. The prize of 2,400 livres was awarded to Daniel Bernouilli.

For the prize of 1747 the academy put under competition the following subject: The best method of ascertaining the time at sea, either during the day or at twilight, and especially at night, when the horizon cannot be seen. This prize, of the value of 400 livres, was divided between Daniel Bernouilli and a person whose name was not stated.

For 1767 the academy put under competition the following problem: To determine the best method of measuring the time at sea. The prize was not awarded, on account of the insufficiency of the instruments, which had been subjected to official tests.

The same subject was resumed at the competition for the prize of 1769, with the following programme: To determine the best method of measuring the time at sea, but requiring as an essential condition that the watches, clocks or instruments, which may be presented for this object, shall have been subjected at sea to sufficient trials, attested by reliable witnesses. The prize amounted to 400 livres and was awarded to the two watches and the memoir presented by Pierre le Roy, but only in the way of encouragement. The academy presented the same programme again for the prize of 1773, when Pierre le Roy offered the two watches*, which had been subjected to the competition of 1769, and Arsandeaux and Biesta each offered one. The prize of 4,000 livres was awarded to the watches of Pierre le Roy. The watch of Arsandeaux obtained an accessit of 1,500 livres.*

If the academy did not remit the same question to competition for the third time it was because in the interval between the announcement and the award of the prizes the French navy, through the care of the minister, Choiseul, was provided with instruments which had undergone the same test as the watch of Harrisson and with the same success. These were the marine clocks Nos. 6 and 8 of Ferdinand Berthoud.

Later, at the time of the decree of the Convention which divided the day into decimal parts, the academy presented the following problem for competition:

*The watch of Biesta stopped before the end of the competition. Romilly had presented a watch for the competition, but in the preliminary test at the Royal Observatory of Paris, it was put out of service by the accident of the astronomer, Lemonnier, who was charged with noting the rates of the instruments for this competition.

The construction of a pocket watch capable of determining the longitude at sea, the divisions to indicate the decimal parts of the day, that is, the tenths, thousandths and hundred thousandths, that is, that the day be divided into 10 hours, the hours into 100 minutes and the minutes into 100 seconds. The competition did not take place, the academy having been suppressed in 1793. But the same prize and the same programme were proposed by the class of mathematical and physical sciences of the institute for the year VI., and two watches Nos. 26 and 32 of L. P. Berthoud obtained the prize. This was the last competition opened by the academy in connection with horology.

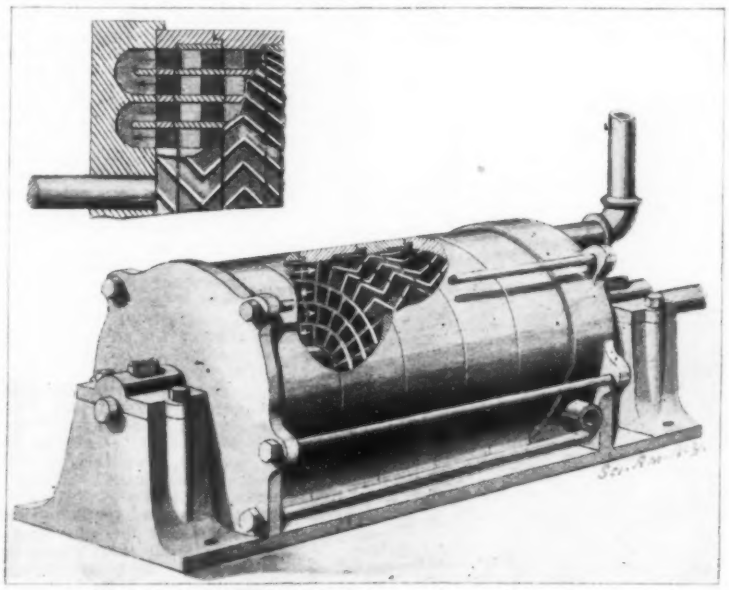
List of the scientists and clockmakers who worked on the problem of the determination of the longitude at sea by the measure of the time:

Huyghens before 1662.
Massy in 1720.
Sully in 1724.
Daniel Bernouilli in 1727.
J. B. Dutertre in 1728.
Gallonde from 1728 to 1747.
Gaudion from 1728 to 1747.
Rivaz in 1748.
Pierre le Roy in 1766.
Romilly in 1767.
Arsandeaux in 1770.
Biesta in 1770.

John Harrisson in England and Ferdinand Berthoud in France, the first in 1734, after thirty years of investigation, and the second in 1769, after fifteen years of investigation, solved the problem of the determination of longitudes at sea by the determination of the time.—Translated from the Revue Chronométrique.

A NEW TURBINE ENGINE.

WE present herewith illustrations of a turbine engine of novel construction which is the invention of Mr. William D. Linscott, of Piedmont, So. Dak. Mr. Linscott has built an experimental engine of this design which has given very favorable results. He informs us that with this engine, which weighs 63 pounds, he has under 40 pounds pressure developed power sufficient to run a lathe, grindstone, small saw, and a number of other devices. The construction is such as to require little or no attention, for there are no complicated running parts to cause wear, and require packing to make them steam-tight. Economy of steam is another favorable feature of this type of engine.



A NEW TURBINE ENGINE.

A glance at the engraving will give us a clear idea of the simple construction. One view shows the engine partly broken away, and with several of the piston sections removed, to show more clearly the peculiar internal, honeycombed structure. The cylinder or casing is made up of a number of annular sections which are held together by tierods that bind the cylinder heads together. Each cylinder section is provided with a honeycombed web, formed by annular series of radially disposed partitions, separated by circular walls. These partitions as shown in the detail view, are formed with two faces disposed at right angles to each other. The cylinder webs are formed at one side of the sections, leaving cavities for the reception of the piston webs. The latter have a construction similar to that of the cylinder webs, with the exception that the V-shaped partitions of the piston have their apices disposed oppositely to those of the cylinder sections. The circular walls of these webs are respectively in register with each other. A steam-tight connection can be made between them by providing the circular partitions of the pistons with ribs to fit loosely in corresponding grooves in the edges of the cylinder partitions. Each piston is provided with an elongated hub. These hubs are keyed to the shaft and project under the cylinder webs so as to give them support. The feed pipe at one end of the engine communicates with an annular cavity in the cylinder head. This feeds steam to the innermost series of openings in the cylinder piston webs. Reference to the illustration will show that these openings form sinuous passages for the steam extending completely through the engine. The steam flowing into the innermost passages enters an annular return port in the opposite cylinder head. This leads the steam back to the next outer series of passages; thence it is again returned, and passed back and forth through the successive series until the outermost passage has been traversed, whence it passes out through the exhaust pipe. Now, it is evident that the steam acting on the inclined walls of the piston webs will give them a rotary motion, while the V-shaped walls of the cylinder frame act continually to deflect the steam and redirect its flow against the piston webs. The steam thus travels a continuous course through the various passages of the engine, and its entire energy is made use of to drive the pistons continuously in one direction. The pistons in turn impart movement to the shaft. Obviously any number of annular steam passages can be formed in the engine, thus increasing its power.

FACTS ABOUT HONEY.

DR. C. F. LANGWORTHY, in Recreation, tells the following interesting facts about honey:

Honey has on an average the following percentage composition: Water, 18.2; protein, 0.4; carbohydrates, 81.2, and ash, 0.2. The carbohydrates are made up of dextrose and laevulose in about equal proportion. Honey contains some aromatic bodies which give it flavor, and sometimes a little wax. The best and newest honey is clear and contained in a white comb. Older honey is of a yellowish tone and sometimes darker. On standing, dextrose sometimes crystallizes out from the liquid honey, rendering it opaque or often thick. The composition of honey varies somewhat according to the food of the bees, their age, season, etc. Hyblas, a mountain in Sicily, and Hymettus, a mountain in Attica, were in ancient times celebrated for their honey, doubtless in consequence of the wild thyme and other fragrant herbs growing on them. Since earliest times man has appropriated the honey gathered by wild bees and bees of different kinds that have been raised in hives to produce it in quantities under favorable conditions.. It is a favorite article of diet owing to its sweet taste and agreeable flavor. The actual food value depends on the carbohydrates present. Like all other carbohydrate foods, it is a source of energy in the body. Honey has a fairly high fuel value, on an average 1,520 calories a pound. It is, however, generally eaten for its flavor rather than for its food value. Honey is most commonly eaten as relish, with bread and other foods. In Europe it is generally served with rolls and coffee for breakfast. Many Americans use honey as they do sirup, with hot bread or cakes. Before sugar was as plentiful as it is to-day honey was used for sweetening foods, and some cakes are made at the present day, especially in Germany and Switzerland, in which it is so used. Candy is sometimes made from honey. It is said that it is always used for making the genuine nougat. Doubtless little of the confectionery which is sold under that name contains honey.

To the ancients who were unacquainted with sugar, honey was of more importance than it now is. "A land flowing with milk and honey" offered the highest conceivable advantages to the Eastern mind. Taken in moderate quantity honey is wholesome and laxative, but persons suffering from digestive disorders often find that it aggravates their symptoms; and there are persons in health who, owing to some idiosyncrasy, cannot eat honey without distress. Its therapeutic action is probably not great, but it is frequently employed in mixtures prescribed for allaying coughs and in various agreeable cooling drinks used in febrile and inflammatory affections.

It should be mentioned that honey occasionally possesses poisonous properties, due to the flowers from which it was gathered. The poisonous honey of Trebizond is gathered from Azalea pontica. In America, poisoning has occurred from eating honey gathered from laurel, Kalmia latifolia and Kalmia angustifolia. Many other instances of poisonous honey are on record.

Honey is marketed in the comb and also extracted from it. The latter, sometimes called strained honey, is frequently adulterated with commercial glucose. It is stated that much of the so-called honey which is sold contains none of the product gathered by the bee, and is entirely artificial. Of 68 samples of honey recently examined by the Massachusetts State Board of Health, 15 were adulterated with cane sugar or commercial glucose, or both. One sample contained as high as 88 per cent of commercial glucose.

THE PILGRIMAGE TO MECCA.

MAURICE BONITEAU BEY, of the Egyptian Department of the Interior, charged with the supervision of the annual Egyptian pilgrimage to Mecca, recently read a paper before the Khedivial Geographical Society of Cairo in which he told many things of great interest. Some portions of his address have been presented to the New York Sun, from which we make the following abstract:

The pilgrims converge upon the holy cities of Mecca and Medina from three directions; those coming from the south are Mohammedans from Oceania, Java, Sumatra, Indo-China, India, Turkestan and southern Persia, who pass into the Red Sea through the Strait of Bab el Mandeb and on to Jeddah, the port of Mecca; the northern branch of the pilgrims, north Persians, Turcomans and people from Asia Minor and European Turkey, go southward to the holy cities both by the land and sea routes; the third stream is from the west, Egyptians, Moroccans, Algerians, Tunisians and Turks, who reach Jeddah through the Suez Canal. For years past the average number of pilgrims passing through the Suez Canal to Jeddah has been 16,000, but this number is sometimes greatly exceeded; the number last year, for example, was 26,000, and in the season beginning in February, this year, it was over 40,000, making 1902 the banner year for the Suez Canal contingent. The northern pilgrims, however, are only a small part of those who annually convene at Mecca. The total number every year exceeds 100,000, practically all of whom are present at the fête of Bairam.

On February 24 last the Kissueh, commonly known as "the holy carpet," was taken from Cairo with great ceremony to be placed on a ship in the Suez Canal and carried to Jeddah and Mecca. The prevalent belief that the holy carpet has any specially sacred significance in the Mohammedan world is erroneous. It is merely a rallying signal for the pilgrims. Its presence stimulates ardor and is a pledge of benediction. The custom of sending every year a holy carpet from Cairo to cover the Caaba at Mecca originated in this way: About the middle of the thirteenth century a Sultan of Egypt named Fatma Chagaret el Dor went on a pilgrimage to Mecca. Great festivities marked his departure. Accompanied by a numerous caravan he made the journey in a superb palanquin that was adorned with the richest of cloths covered with gold and precious stones.

KOREA'S CURIOUS CURRENCY.

AN interesting report has just been issued by the Foreign Office on the trade of Korea for the year 1901, by Mr. H. Goffe, Acting British Vice-Consul at Chemulpo. It states that the chief difficulty with which foreign trade has to contend is the disastrous condition of the currency throughout the empire. The Korean government, in defiance of the first principles of sound finance, is flooding the country with a nickel coinage whose intrinsic value is only one-eighteenth of its face value, without any gold or silver reserve with which to redeem it. As a natural consequence these coins, which under proper conditions should be merely tokens, are at a continually increasing rate of discount as against Japanese gold yen, the recognized basis for calculation of prices where foreign articles are concerned.

Hitherto the circulation of nickel pieces has been confined to the capital and the neighborhood of two or three of the treaty ports, the old cash being current elsewhere in the country; but recently, with a view to making their use general, the magistrates throughout the empire have been ordered to accept payment of the land tax in this currency only. The face value of these coins is 5 sen, and they now stand at a discount of 90 per cent, as against Japanese gold yen. The wages of Korean laborers and employés generally are paid in this currency, and this class, which comprise the bulk of the nation, are no better paid now than they formerly were; consequently the purchasing power of their earnings, as far as foreign goods is concerned, is little more than half what it was a few years ago. And, unfortunately, there does not seem any prospect of these conditions being improved in the near future. The government, caring only for the profit they are making out of this transaction, and ignoring the permanent harm they are doing to the country, are bent upon continuing their present reckless course, and 40,000,000 more of these coins, contracted for with an American firm, are now almost due for delivery. The issue of these will bring the total face value of this coinage in circulation up to 14,000,000 yen, or more than £1,400,000.

But even this is not the worst feature. The number of counterfeit nickels is rapidly increasing; permits to coin are freely issued by the government to private individuals; nickel is openly imported through the customs, and spurious coins in large quantities are brought by almost every steamer from Japan and smuggled into the country. The Commissioner of Customs at Chemulpo in his annual report writes as follows: "The $95,000 worth of nickel, against $42,000 in 1900, have, it is feared, been entirely employed in manufacturing counterfeit nickel coins." The fact that in Chemulpo quotations are current for (1) government nickels; (2) first-class counterfeits; (3) medium counterfeits; and (4) those passable only after dark—will show what a condition affairs have reached.

This currency question is of vital importance to foreign merchants, and is engaging the earnest attention of the foreign representatives. Japanese silver yen, the supply of which seemed to be exhausted in 1900, have again appeared in large quantities, most of them having come from the interior where they were hoarded by the natives. They are now at a discount of 13 per cent as against gold yen. The largest of the copper cash continue to be exported to Japan, where they are melted down for the value of the copper they contain. No progress has been made by the Korean government with their projected subsidiary silver coinage, although silver to the value of some £85,000 has been imported by the Imperial Mint for this purpose. —London Globe.

AERODROMES.

By S. D. Mott.

The accompanying illustrations show what is believed by a number of conservative engineers, mechanical experts, and the writer, to be a practical and commercial solution of the problem of mechanical flight.

The device, technically called an aerodrome (air runner), is a new type in the aeronautic art, and for this reason and others it has been called, by those before whom the principles of its operation have been demonstrated, the twentieth century navigator of the air.

The present writing will be confined to a description of the machine, its mode of control, its chief characteristics, and its arithmetical plausibilities based upon what others have done with aeroplanes.

The design shown is the result of the inventive endeavor of the author, after years of research and frequently interrupted study, of a very difficult subject at best, and is an earnest effort to clear the subject of the so-called insurmountable difficulties presented by the problem, the unrealities of which are by no means easy to see because all questions pertaining to the mechanics of flight are entirely beyond our every day experience with physical laws.

In these up-to-date times, the extent of the prejudice existing in the mind of the average man regarding the navigation of the air is surprising. Strange to relate, some have even said that the subject has been exhausted. Hardheaded business men will not realize that, like other physical problems, this one must needs undergo evolution. Many intelligent failures have been recorded and, as a consequence, the subject is unmistakably looked upon askance. This, however, is only the history of all of the more important inventions which have produced our modern civilization. Certainly man cannot expect to attain the life instinct and hereditary skill of the fish in navigating the waters of the earth. Neither should he expect to rival the bird in traversing the air; but man does navigate the waters successfully and quite satisfactorily, though not perfectly, and as certainly, to the student of modern progress, will he navigate the air.

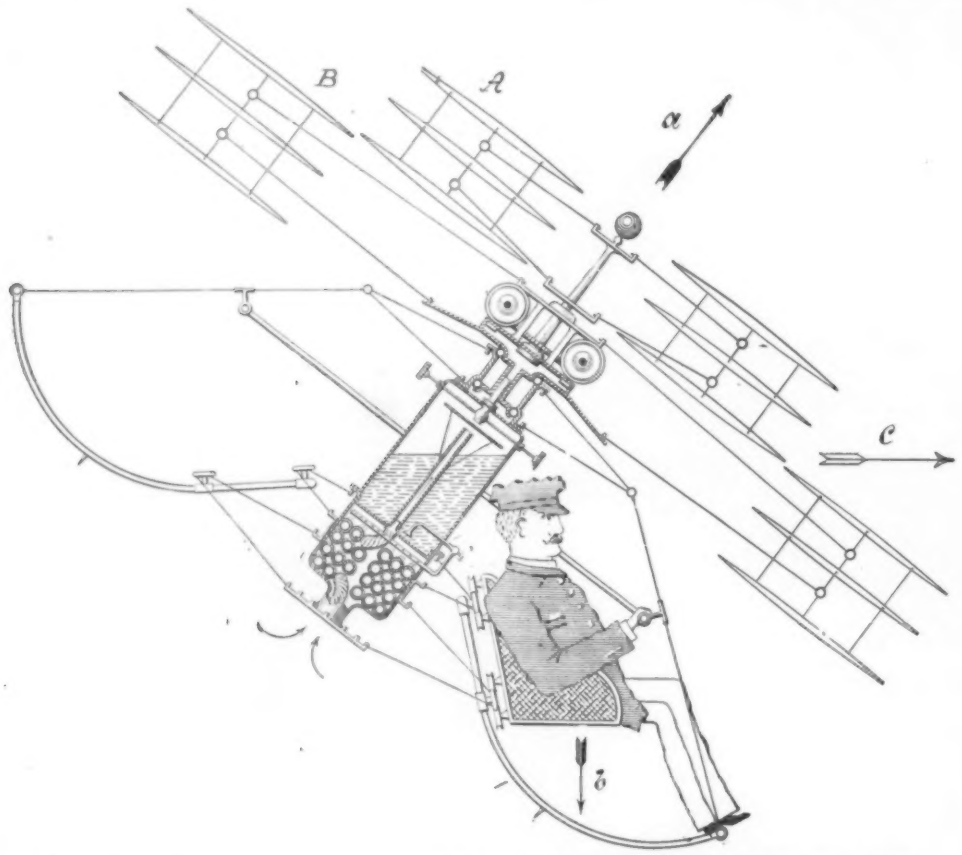


Fig 1.—POSITION OF THE AERODROME IN THE AIR, SHOWING HYDROCARBON PRIME MOVER.

Physically the two media air and water are similar. For our purpose their densities only differ, which means that it requires more power and less weight to attain the same fulcrum in the former than it does in the latter. On the other hand, to differentiate between navigation in the one and navigation in the other, it is only necessary to point out that, whereas on the water controllable propulsion is the primary requisite to be provided, in the air, not only controllable propulsion, but sustentation also must be attained. This states the problem past, present and future. In the aerial machine here illustrated these two fundamental functions are one; in other words, its design is such, that, if there is sustentation it follows there must be controllable propulsion. The stability is automatic, self-contained, and is the natural sequence of shape, which for maneuvering devices, which add weight and need skillful handling, there are none. This surely is common sense, and such nearly ideal conditions I will endeavor to show are not at all unattainable.

At the outset let it be plainly stated that there is no absurd thought of superseding the railway or transoceanic steamship as a means of transport. The writer does not believe that the air will ever substitute the rail as a means of general transportation of passengers, freight, or heavy merchandise; certainly not until our present physical limitations are to a great extent revolutionized by future discoveries. What is aimed at is to carry one or more persons and their belongings a definite time and distance through the air with precision and an ample factor of safety. There is no attempt to imitate bird, balloon, or kite. The action is altogether dynamic. We do not imitate the locomotion of land animals in operating our railways, and to my mind it is certain we will not fly dynamically, if to succeed we must imitate the intuitive skill of the bird in its element. Much money has been spent, however, by governments and individuals, and all the best-directed efforts of late years have been along these lines, but they have not been shown to be progressive.

The subject is viewed here broadly as a purely mechanical proposition of primarily high velocities. The air is usually looked upon as a very attenuated and innocent medium, but who has not seen its tremendous power when in motion. As an instance, during the Galveston disaster of 1900 the wind velocity at its greatest was one hundred and twenty miles per hour, or two miles per minute, and the wind is reported to have swept everything which met its force. In the St. Louis wind storm of 1896 it will be remembered that parlor cars weighing twenty tons were tipped over bodily and utterly demolished. The average size of such a car is sixty feet long and about ten feet high above the wheels, thus aggregating eighty-six thousand four hundred square inches of aeroplane surface which was acted upon by moving air with sufficient force to lift twenty thousand pounds, or ten tons, approximately. Now this proved plainly that a fulcrum by the air for leverage is a matter of velocity, and conversely a fulcrum on the air for leverage is likewise a matter of velocity of the moving elements—a significant physical fact followed by a self-evident truth, and a neglected point that must not be lost sight of, but taken into serious consideration in all questions pertaining to the art of orthogonal* flight.

Referring to the machine under consideration, aside from the motor, it has the elemental simplicity of the bicycle. It consists of two wheels mounted at the apex of a tripod-like frame; the latter supporting the machine on the surface and the aviator† in the air. The design is concentric, obviously, for compactness, cheapness, strength, simplicity and lightness. The materials employed are aluminium, cold-drawn steel, celluloid, and bent wood. It is inexpensive to construct and requires no starting or landing arrangements, and is capable of all necessary maneuvers in the air without adjuncts such as unstable tail or rudder and wing appendage or gas-bag impediment. It is dismountable and transportable, and therefore especially adapted for army and navy use, travelers and explorers, science and commerce, and the general uses of man. It can be used in the army for reconnaissance, signaling, etc.; in the navy for the same, and as a substitute for launches. No design for an airship as yet suggested can make a pretense, as can this, to rise from the deck of a battleship and return to it with any degree of certainty.

The theory of sustentation and translation from place to place through the air is founded on and explainable by the rule of resultant and compound forces, known to physicists as the parallelogram of forces. For example, referring to Fig. 1 of the drawings, the arrow, *a*, indicates the direction of thrust of the driving wheels or the dynamic component of the machine; arrow *b* the constant pull or component of gravity, and the arrow *c* (the horizon) the resultant or intermediate direction of motion. The machine will thus be impelled as though acted upon by a single force in the direction of arrow *c*. Hence the horizontal path of the machine is the resultant of two component forces, the artificial force residing in the machine and the natural force of gravity. By controlling the first the second is utilized and thus is substituted for working parts, a physical principle, or a natural law.

From the above it follows that the control of the direction of flight is based upon and determined by the center of gravity. It will be observed that the aviator is free to shift his position circumferentially around the machine on the seat provided. In the air the center of gravity or the angle of the axis to the horizon is determined necessarily by the load displacement and the normal load is the aviator or aviators. Hence the position taken at starting determines the direction of flight by compass, and by shifting position the direction must be correspondingly changed. The initial lift from the surface of the earth is vertical, the normal position in the air is oblique to the surface or horizon, and the normal direction of lift a tangent to the horizon. The angle of this tangent is greater or less as willed by the operator, and the more acute the angle with the horizon or the greater it is with a vertical imaginary line, the greater will be the speed of translation, and the shorter the time required to travel between two objective points.

The ascent and descent is governed by the throttle which regulates the power applied. If it is desired to go over an object the power or ascensional force is increased; if it is desired to go under an object the buoyancy is diminished. An aviator would go around an obstruction by shifting right or left at right angles, or approximately thereto, to the sight-line of the obstruction. Progress is checked as by a brake by the aviator changing his position opposite to the direction of flight thereby reversing the resultant thrust of driving wheels, but not their direction of rotation; in other words, the center of gravity is determined rearward the same as bipeds or quadrupeds retard their forward impetus. By checking the speed of the driving wheels the machine must descend; if in a strong wind, at the point of settling or landing the aviator would shift his position to the windward; if in still air, ordinary care need be used to cause the machine to settle with precision and safety. A position of the aviator in the vertical axis would cause it to alight on an even keel. In high winds or storms of exceptional violence the same caution and common sense should be used as with other means of conveyance. This aerodrome can only be upset by exceptional conditions of violence, and such conditions are more easily avoided when navigating a hundred feet from solid earth, than when cruising in a yacht two miles in the offing or two hundred miles at sea.

In this connection it may be curious to note the close analogy between the maneuvering of the flying machine and the principles which control the movements of land animals, particularly bipeds. Man's first act in walking or running is to unconsciously displace his center of gravity; and the direction of this displacement will be the direction of his movements. If he stops he intuitively brings the center of gravity in line with the vertical axis of his body. If he wishes to retard his forward impetus he will as unconsciously throw his center of gravity rearward; and curiously, if he would increase his speed of translation he will increase the speed of his propellers and decrease the angle of his vertical axis to the horizon. If it were a matter of traveling vertically, the machine would be maneuvered spirally like the bird, which never flies straight up. Man or other animal wishing to reach an elevation, if he would economize his strength, or has not the power to go straight up, will very sensibly find the means to go spirally.

Fig. 1 shows, in side elevation, partial section, to obviate confusion to the eye, the ensemble of all the elements of a complete machine in a position as it would appear in the air traveling to the right in the direction of arrow *c*. The principal views in the drawings accompanying, viz., Figs. 1, 2, 3, 4, 6 and 7, are made to scale of 1 inch to the foot. Fig. 1 on the ground stands about 6 feet high and nearly 12 feet diameter over all. The fuel for the prime mover is gasoline, alcohol, or other more suitable and efficient hydrocarbon. The motive agent is carbureted air consisting of about fifteen parts free air at normal pressure, which costs nothing and is not carried. The fuel retainer and the carbureter beneath it constitute the backbone of the machine. The carbureter, in this instance, consists of coiled porous fabric tubing continuously saturated with the fuel hydrocarbon and through which the air is drawn by the suction action of the pistons of the explosive gas engines of special construction.

The tangent spoke wire-wheel is without doubt the strongest and lightest structure devised by man. The driving wheels, *A* and *B*, are piano wire spoke wheels of cycle pattern, modified to the extent of double rims made of bent wood or tubing. Mounted on the rims and detachable, if desired, are series and tiers of aluminium or celluloid aeroplanes having the proper shape and pitch to form an efficient aerial screw. The motor is usually integral with the driving wheels and preferably incorporated at the common hub. These wheels when in motion constitute the plane of buoyancy. They are revolved in opposite directions by the acting and reacting elements of the motor in order that the action and reaction of the motor, when free from a fixed base, shall be absorbed in the driving. Hence the dependent and supporting parts, together with the aviator, have freedom of motion relative to the driving wheels. The driving wheels are mounted on ball or anti-friction bearings, and the engine cylinders are in some instances mounted on ball bearings.

As the entire weight and load of the aerodrome is wholly below the plane of buoyancy, and while operative must remain so, the machine is vastly more stable in theory than a yacht or other water craft. Should the factor of safety fail and something break, the machine would descend slantingly like the apparatus used for aeroplane gliding or tobogganing flight. However on this point it is well to remember that a hundred feet in the air is better, safer, and more sensible, than a mile or so, for navigable purposes.

It is estimated that this machine skillfully constructed can be made to weigh considerably under two hundred and fifty pounds; including operator, say four

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* A term coined by the French Academy to indicate flight in which the weight is sustained by direct downward thrust upon the air.

† Coined to designate the driver or operator of an aerodrome.

hundred pounds. Using the power illustrated in Fig. 6, the weight would be around two hundred and twenty five pounds, including fuel and prime mover; the latter being rated at thirty horse power. The absorption of power is rated at about thirty horse power in starting, and one-half this, or fifteen horse power, for navigating.

It has been frequently stated as a general proposition that two hundred and fifty square feet of aeroplane surface driven through the air at forty miles per hour will lift one thousand pounds. Hargreave demonstrated that an aeroplane forced through the air at twenty miles per hour will lift two pounds per square foot. The average result of experimental efforts is usually stated, at twelve miles per hour, to be one pound lift per square foot of surface. Taking speed

FIG. 2.—CELLULOID OR ALUMINIUM AEROPLANES.

into consideration, the above mentioned results are substantially parallel. Arranged as in Fig. 1, with circular planes thirty inches in diameter, (as per Fig. 2) the machine carries three hundred and thirty-five square feet of aeroplane surface. The rim speed of the larger wheel, nine feet in diameter, at four hundred revolutions per minute, is over two miles per minute, or one hundred and twenty miles per hour. The rim speed of the smaller wheel, four feet in diameter, is about one mile per minute, at four hundred revolutions per minute, or sixty miles per hour.

Prof. Langley experimentally records a lift of two hundred pounds per horse power with an angle of incidence of two degrees to his aeroplanes. This may have been attained straight away through the air instead of circularly. In his machine it is said he

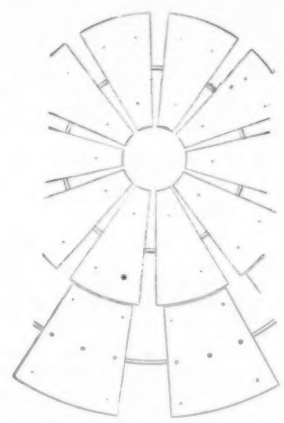


FIG. 3.—TRAPEZOIDAL SHAPE AEROPLANES.

attained twenty-eight pounds per horse power. Mr. Maxim attained about the same and Mr. Chanute *forty-four* pounds per horse power. *These figures average about four times that which is necessary for the machine shown in Fig. 1 to navigate the air, carrying two operators, and using a thirty horse power motor; and nearly twice what is necessary when the first item (two hundred pounds per horse power) is eliminated.*

Fig. 2 shows the circular form of aeroplane and Fig. 3 the angular shape. Fig. 4 is a broken plan with the driving wheels and motor removed showing the foot rest, 21, the hand rail, 22, the curved legs, 18, and the operator's seat, 2, on its circular ways, 3 and 4, on which it may be moved circumferentially around the machine. Fig. 5 shows the relative positions of two tiers of aeroplanes, one on each wheel, viewed from the side looking toward the center of the machine. Fig. 6, the plane of buoyancy, is modified to a wheel within a wheel for compound action on the air to increase the leverage for a given disk area. In these sketches a form of prime mover is shown using acetylene or other suitable gas compressed or liquefied. Or the liquid gas may be absorbed in acetone as is now being introduced for the lighting of railroad cars. The retainer is a tube, shown seven inches in diameter, to contain 1,386 cubic inches of the liquid, which, on expanding to atmospheric pressure, will make over 321 cubic feet of gas which will furnish thirty horse power

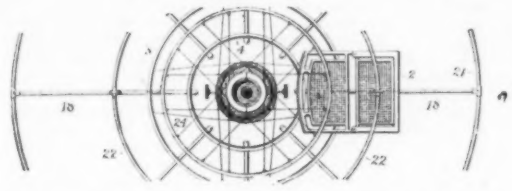


FIG. 4.—PLAN OF MACHINE—DRIVING WHEELS AND ENGINE REMOVED.

for about two and a half hours. (Authority for this statement is the data contained in the works on gases by Lewes, Frank and Hiscock.) The pressure in the liquid retainer is reduced in the intermediate chamber from twenty-seven to about twelve pounds to the square inch by a regulator. Another form of hollow trunnion gas engine is adapted to acetylene, in which the gas is taken in and forced into the explosive chamber at each reciprocation of the duplex diameter piston. The valves are internal and there are no eccentrics or trip movements. The cylinders are made of cold-drawn steel machined in some of their parts. At each reciprocation of the piston the explosion chamber is reduced to atmospheric pressure and at the same instant a blast of fresh air is injected into it from the front end of the cylinder. For this reason, and the additional considerations of the violent commotion of the environing air and oscillation of

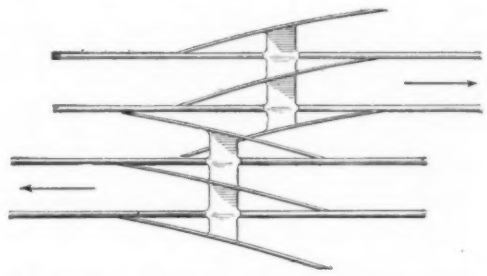


FIG. 5.—SIDE VIEW OF THE AEROPLANES LOOKING TOWARD THE AXIS OF THE MACHINE.

cylinders as also ample exhaust, it has been shown that it is not necessary to have a water jacket for cooling purposes. Fig. 12 shows the grouping of the trunnion engine cylinders for direct connection to the crank; the cylinders have a motion around the central axis indicated by an arrow, while the crank and its shaft rotate oppositely. Fig. 13 is a section exposing the direction and path of gas fuel feed. Fig. 14 is a form of trunnion gas engine in which the gas is taken into the engine through the piston and the air through the trunnion. In the plan of this arrangement, Fig. 15, gears or their mechanical equivalent are incorporated for changing the velocity ratio between the power and its point of application for the obvious purpose of increasing the power for a given weight at the expense of speed as is exemplified in automobiles and steam turbines; the gear proportion as shown is two to one, hence, with the engine making 1,600 revolutions per minute, 800 revolutions per minute will be transmitted to the driving wheels, or 400 revolutions per minute to each driving wheel. Planned and skillfully constructed on the above lines, this prime mover should give a horse power output considerably under five pounds weight. Fig. 16 is an end elevation of Fig. 15. Friction rollers running on ball bearings are arranged to

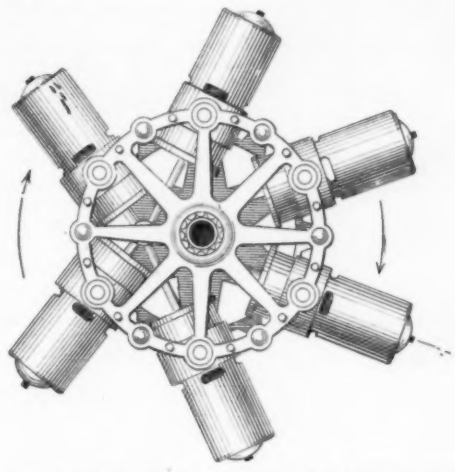


FIG. 12.—ENGINE CYLINDERS GROUPED FOR DIRECT CONNECTION TO CRANK AXLE.

support the engine and driving wheels upon the understructure, and these parts are made readily removable. Fig. 18 shows one of the expedients to absorb the thrust of the explosions in the engine by storing the energy in springs instead of in a flywheel as is usually done, the springs being used to save weight. Figs. 19 and 20 show a longitudinal and cross-section of a trunnion engine which is to be made of cold-drawn steel for the use of steam, carbon dioxide, liquid air or other expansive non-explosive gas, and Fig. 21 shows the three positions of the trunnion valves. The first is on the dead center, the second

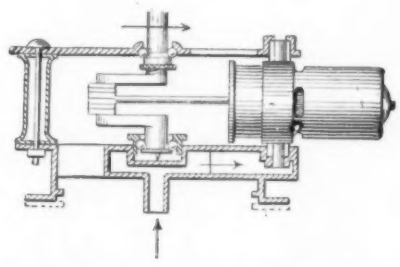


FIG. 13.—ENGINE AND CRANK MOUNTINGS.

admits to the right end of cylinder, opening the left end to the exhaust, and the third position opens to the left end of cylinder, and the right end to the exhaust.

Now what are the probabilities of commercial success with this device? One of the ways, of course, to form an intelligent judgment is to draw mathematical parallels between what others have done with aerial screws of given dimensions and given speed, and deduce therefrom what this machine should do under like conditions.

Among other available and specific data for mathematical deduction on this point is that recorded by Mr. Maxim with his experimental machine at Baldwyns Park, England. The application of the rule of

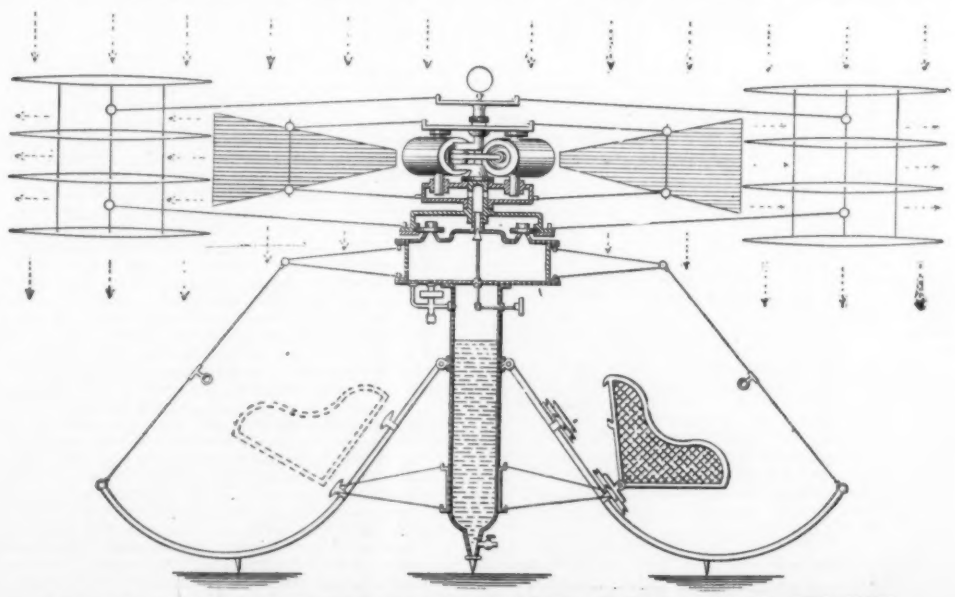


FIG. 6.—POSITION OF THE AERODROME RESTING ON THE GROUND, SHOWING ACETYLENE MOTOR.

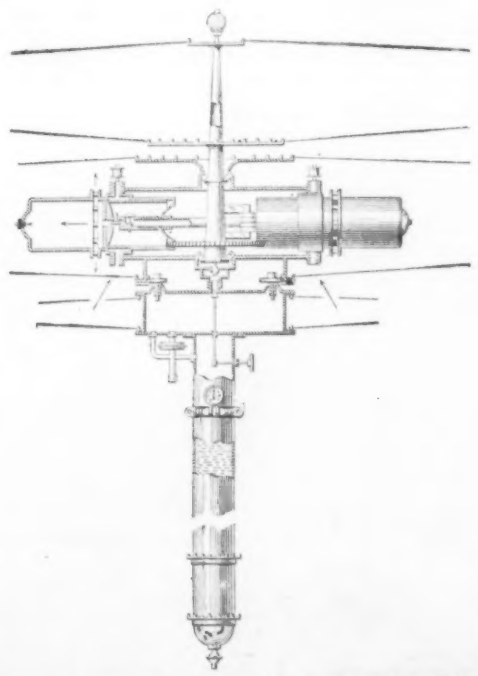


FIG. 14.—ENGINE CYLINDERS GROUPED FOR SPEED-REDUCING GEARS.

three should yield, other things being equal, close approximations to what may be expected without taking into account the evident superior efficiency of the screws illustrated owing to their structural features.

With circular aeroplanes as per Fig. 3 mounted as per Fig. 1 (twenty tiers of three planes each; all planes thirty inches diameter), the aeroplane surface aggre-

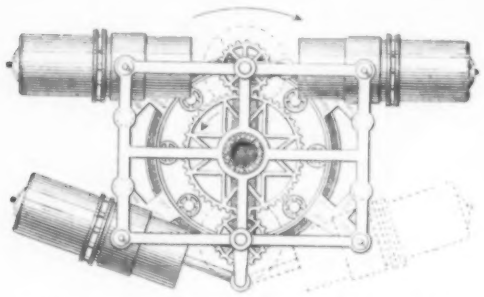


FIG. 15.—PLAN OF SPEED-REDUCING GEARS.

gates 12,411 square inches. The limit of increase of aeroplane surface with due increase of efficiency, has not been fully determined. Three hundred and fifty square feet (50,400 square inches) are easily disposed without crowding or modification of structure.

The surface area of Mr. Maxim's two screws (17 feet 10 inches diameter by 5 feet wide at large end by 22 inches at waist), is 17,550 square inches. The sum of their disc areas is five hundred square feet. They were made of yellow pine and fashioned like steamship screws.

The best results attained with these screws at three hundred and seventy-five revolutions per minute was two thousand two hundred pounds thrust.

As per Fig. 1, assuming the same speed of revolution, if 2,200 pounds is the lift of screws having 17,550

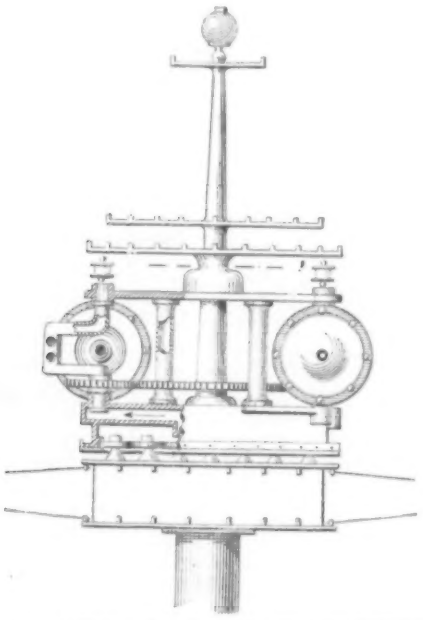


FIG. 16.—END VIEW OF SPEED-REDUCING GEARS, SHOWING PATH OF GAS TO AND THROUGH THE PISTON.

square inches of surface, what should 42,411 square inches lift?

17,550 : 42,411 :: 2,200 : *X*. 5,344 pounds.

Again, as per angular aeroplanes Fig. 3, if 2,200 pounds is the lift of screws with 17,550 square inches of surface, what should 30,890 square inches lift?

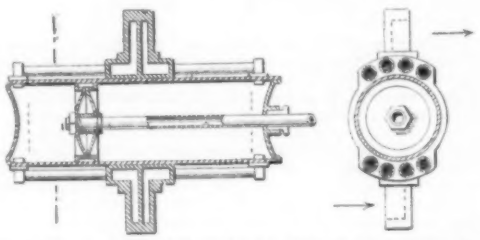
17,550 : 30,890 :: 2,200 : *X*. 3,872 pounds.

This seems more than should be anticipated, and we will take the possibly, but not certainly, truer criterion, the disc area of displacement of the driving wheels considered as one wheel. The true result will most likely be found somewhere between these two methods. The disc area of a circle 12 feet in diameter is 113 square feet, and proportionately compared with Mr. Maxim's two wheels of 500 square feet disc area, will give a lift to our driving wheels of 500 pounds in

FIG. 18.—SUBSTITUTE FOR FLYWHEEL TO TAKE THE THRUST OF THE EXPLOSION.

round numbers, or sufficient for *one person to navigate the air and have over* 100 *pounds to spare for contingent load*. Should this not be sufficient, it is only necessary, as has been shown, to increase the revolutions above 375 per minute, or, increase the disc area of displacement. If the latter is increased 14½ feet, arithmetically, 726 pounds will be the lift; 15 feet, 776 pounds; 18 feet, 1,119 pounds, etc. There is a structural limit to the disc area, and no doubt a limit to the increase of speed with corresponding increase of efficiency, as also to aeroplane surface per disc area of driving wheels. These points have not been fully determined so far as I am aware by an experimenter of record.

As has been stated, we have assumed thirty horse power for driving the machine. Mr. Maxim obtained two hundred and fifty pounds lift per horse power maximum, which is no doubt impractical, and he acknowledged it could not be maintained. He again records the absorption of eighty horse power in driving his screws when starting, and forty horse power when in the air. This is at the rate of fifty pounds thrust and twenty-five pounds thrust per horse power respectively, and may be taken as a fair average of what has frequently been done by all the prominent experimenters. Taking the lesser figure and applying it to Fig. 1 there should be a lift of 750 pounds. As 550 pounds is about the heft of this machine, including two persons of average weight, it will be seen that *the air would be navigable dynamically with two aviators and two hundred pounds to spare for contingent load*. In fact, the mathematics is so greatly on the side of the twentieth century machine that we feel safe in the dimensions and power assumed, whatever reasonable contingencies may arise. These simple calculations



FIGS. 19 AND 20.—SECTIONAL VIEWS OF STEAM, LIQUID AIR OR CARBON DIOXIDE ENGINE.

do not portend, necessarily, nor pretend conclusive proof of the premises, but it may be added that figures based on experiments and mechanical common sense have been the pole-star leading to the present development.

The concisely stated ideal requirements of a would-be successful flying machine, as given by Mr. John P. Holland, of submarine boat fame, are here again recorded because it is believed that this machine meets them squarely.

First. The machine must be able to lift and support itself in the air.

Second. It must be incapable of tipping over or upsetting.

Third. It must be capable of rising and alighting vertically and slowly or rapidly at will in storm or calm.

Fourth. It must be easily and steadily steered in any direction.

Fifth. It must be a complete machine, and each of its parts must have a safety factor of from six to ten, that is, it must be so strong that there would be required to destroy it a stress of six to ten times greater than any to which it is ever likely to be subjected.

In conclusion it must be acknowledged that this conception eliminates from the problem of man-flight the confusing devices usually considered indispensable for maneuvering a so-called air-ship. For its operation there will be required, as with all innovations, some experience but really less skill than riding a bicycle, sailing a boat, or maneuvering an automobile. The only requisite with this type of machine is that it shall have sufficient lift in the driving wheels supplemented with sufficient power in the motor to yield the dynamic thrust to overcome gravity when starting and just neutralize gravity when navigating; or, as it has been more scientifically stated by a practical, conservative engineer, one of the faculty of Columbia University, "The plan of controlling the direction of the lifting components of your machine by shifting the center of gravity is sound. I therefore have no doubt that dirig-

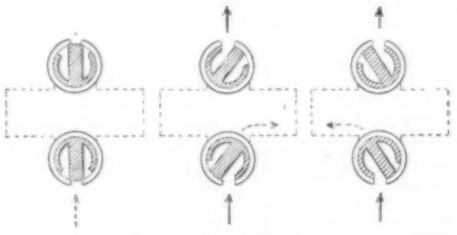


FIG. 21.—DIAGRAM OF VALVES FOR EXPANSIVE GAS ENGINE.

ible flight can be secured by the methods which you advance. It simply becomes necessary to have sufficient energy so that the component velocity to be combined with that due to gravity shall have a resultant force inclined upward from the horizon to enable the machine to rise and move in the desired direction."

All has not been said by any means nor is it deemed necessary at present to disclose certain details, special features of construction, or modifications and extensions of the idea; but enough has been shown, it would seem, to warrant a full-sized, crucial, inexpensive test, which would demonstrate its practicability and yield the data on which to build a commercial machine.

OUR ICE CREAM BILL.

STATISTICS are not available, but we, as a nation, are addicted to ice cream to an extent almost beyond belief, says the New York Press. One company in New York, the largest and most important in the country, sells something like 100,000 quarts a day. Its capital stock is only $40,000, and all its officers and directors are millionaires. Eighteen or twenty other companies do a large business, besides which there are numberless confectionery shops which make their own and dish it out in a small way over the counter. Possibly the daily consumption in Greater New York is 200,000 quarts, and the average price is 30 cents to the consumer. This makes our ice cream cost us $60,000 a day, or nearly $22,000,000 a year.

BUSINESS OPPORTUNITIES IN PORTUGUESE COLONIES.

CAPITAL seeking investment and American producers seeking new markets—recognizing the force of the economic truth that in order to get something out of a country, something of value must be put into that country—are turning with intelligent curiosity to the colonial possessions of Portugal in Africa, if one may be guided to an opinion in the matter by the letters which reach this legation, asking for information concerning the resources and potential riches of these colonies. To meet this demand, I have taken pains to communicate with a number of men here who have been foremost in developing the trade with the colonies of Portugal in Africa and may be accepted as expert authority on the subject. One who has been for twenty years at the head of perhaps the strongest firm having large interests in these colonies said:

"The most important African colony belonging to Portugal, and the one in which the largest fortunes have been made within the last thirty years, is Angola. The colony of Angola comprises 517,000 square miles and has a sea line of 1,400 kilometers (870 miles). The climate, if tropical along the coast, has proved healthy enough for Europeans nearly everywhere in the interior. I speak from practical experience. There is no soil on the surface of the globe more fertile than that of Angola, and only a few years ago this colony was practically the second largest producer of rubber in the world. In 1899, it exported rubber, in the face of grave difficulties, to the value of $4,500,000, besides large quantities of coffee and other products.

"There are also found in large and paying quantities palm oil, palm nut, cocoa, and excellent hard woods. In Loanda, there are great deposits of copper, and in the southern part of the colony, near Mossamedes, gold has been found, and there is undoubtedly a great future in mining there.

"The climate, topography, and soil of Angola would render comparatively easy the cultivation, on a very large scale, of such crops as cotton, tobacco, coffee, rubber, and certain cereals. Native labor is ridiculously cheap, and when intelligently directed, is most excellent."

Another man who has large interests in the Portuguese colonies in Africa, and has spent much time in Angola, says:

"The country is eminently suited to the requirements of sheep raising. The interior is very healthy. I have been much interested in the development of the mineral resources. Nothing of a systematic or very scientific nature has been done in the way of looking for the valuable minerals, but enough has been seen to prove that copper, silver, and coal exist in very large quantities, and even quite near the coast strong indications of all these mineral riches are found. The existence of petroleum in large quantities has been demonstrated, and a Portuguese company is now at work drilling wells. The petroleum fields are near the coast."

A man who for twelve years was at the head of the mercantile house which at the time did the largest business with the African colonies of Portugal, writes as follows:

"The question of labor, about which you ask, is not difficult to solve. The negroes are good workmen and the Portuguese colonists are hard-working, sensible men. The great product of these colonies for the present moment is rubber. There are apparently inexhaustible supplies of it. You ask me then, if this is so, why Portuguese Africa has not prospered like the Congo country, which is administered by the Belgian government. I will tell you. The whole difficulty is one of administration. The rubber in the Portuguese colonies is brought down from the remote interior districts by bearers, who have sometimes a journey of two months to the coast to exchange their produce for money or goods.

"As soon as one gets into the interior, there is an absence of roads and a great paucity of government military stations or trading posts. The country is slightly policed. The consequence is that the negro bearer who carries his rubber has a long, dangerous, difficult journey, and is robbed of a portion of his stock from time to time; and when he returns to his village, if his chief be informed that there is smallpox on the coast, he is likely to be summarily shot by his own people. They have simple but very effective quarantine methods among the natives in Africa. Notwithstanding all these grave difficulties and disadvantages of a practical nature, the trade in the Portuguese colonies thrived enormously until the Congo State appeared. Then, system, order, and far-seeing patience began to tell, as they always do. With admirable foresight, the government of the Congo State developed a vast network of trading stations in the interior of its territory and built flat launches to bring the produce to tide water via the water ways and rivers of the country. This sort of navigation costs very little. In short, the Congo government brought the market close to the producer; and as a consequence of this system and organization, it is able to underbid in the rubber trade the very country where rubber most abounds. The rubber is purchased on the spot, and the native is spared the danger and toil of a long journey to the coast.

"In this connection, it should be observed that both the Congo and Angola only export rubber produced by 'wild-growing plants,' and though the field is still an enormous one and may be exploited in the present manner for thirty or forty years longer, the ultimate system will be to cultivate the rubber plant systematically. Already, a good beginning in the way of setting out rubber plantations has been made in the Congo, but I think nothing of this sort has been done in Angola.

"With the highly organized and scientific methods of the Congo State, the Portuguese merchants and dealers

have found themselves unable to cope profitably. The negroes refuse to come to the coast with their rubber; they prefer to sell on the spot, as it were, in the Congo.

"The rubber trade in Angola could readily be revived by proper combination and management. The various existing interests would have to be consolidated in some well-working way, and this would be a comparatively easy matter. Then an intelligent system of development would have to be evolved and vigorously and patiently prosecuted. It would be wise to obtain a charter from the government, if possible, giving wide scope to the company in the way of administration, policing, and the protection of its rights. In return for such favors, the company would have to build roads and establish trading stations. This it would have to do in any event, and success would depend upon the thoroughness with which it was done. There is a vast stream of practically permanent revenue awaiting the man, or group of men, who can bring a proper amount of administrative ability, talent, and capital to the development of the resources of these colonies. In all the continent of Africa there is no richer and more inviting spot, so far as natural resources are concerned. The old haphazard methods have had their day. The new era has come and it awaits a man.

"There should also be completed the Ambaca Railway, now reaching to Lucalia, a distance of 364 kilometers (226 miles) from the coast. This road is intended to go to Malange, 200 kilometers (124 miles) farther. There has also been approved the project of the Benguela Railway, from the port of Benguela to a point in the interior about 500 miles distant. The government is very desirous of having these roads built, and would make very favorable conditions for anyone undertaking the task."

I have consulted several other men who are personally acquainted with the African colonies and the conditions which obtain in them. The information received in every case was in harmony with the views expressed in the foregoing statements. There appears to be no reasonable doubt of the magnitude of the riches with which nature has endowed most of the possessions of Portugal in Africa, and it seems to be equally clear that for the sufficient and adequate exploitation of those riches, new methods and additional capital are of vital and immediate importance, in view of the capable and growing competition in colonial trade furnished in the Congo State.

The main difficulties which foreign investors in the African colonies of Portugal are likely to encounter will arise from the variety of constructions put upon the law governing the creation and management of corporations formed for the purpose of transacting business in the colonial possessions of this Kingdom. This law is not at present thought to be wholly favorable to the investment of foreign capital in the colonies.

I append some notes concerning the Portuguese colonies, compiled from official sources. These notes, while meager in detailed information from a commercial point of view, serve to show the variety, number and extent of the Portuguese colonial possessions. —Francis B. Loomis, Minister at Lisbon.

PORTUGUESE COLONIES IN ASIA.

India.—New Goa (Nova Goa), or Panjim, capital of the Indian territory, is built near the mouth of the river Mandovi, in the northern part of the island of Goa. It is the seat of the archbishop of Goa, this prelate bearing the title of "patriarch of the East Indies." Here is also situated the court of judicature, having jurisdiction over all districts in Indian territory—the five islands of Goa, Bardéz, Salsete, Bicholino, and Tuepem—and the provinces of Macao and Timor.

In New Goa is also the residence of the governor-general. It possesses good modern buildings, a medical and surgical college, a hospital, extensive barracks, custom-house, lyceum, archepiscopal palace, a school of art and industry, a department of public works, a governor's palace; Portuguese, Musselman and Hindoo schools; library and government printing office, observatory and lighthouse.

The principal exports consist of cocoa, salt fish, dried fish, timber, cotton, cattle, bamboo canes, coir, myrabolans, pepper, rice, woven fabrics, oils and salt.

The principal imports are tar, pitch, shirt collars and cuffs, laces, hosiery, arms and ammunition, needles, wines and spirits, tea, coffee, corks, drugs, spices, wheat, tamarinds, European butter, cheese, sugar, boots, cloth, carpets, jewelry, cutlery, iron, paints, tobacco and vehicles.

The area of the Portuguese colony in India is about 1,200 square miles; population, 561,384 inhabitants; public revenue, 940,886 milreis;* public expenditure, 1,057,564 milreis.

Macao.—A city situated in latitude 24 deg. 11 min. north and longitude 122 deg. 40 min. west of Lisbon; population, 71,800 inhabitants; built on a small peninsula south of the Chinese Empire. It is the capital of the province and possesses some noteworthy buildings—four fortresses, a cathedral, castellated convent, three hospitals, ten churches, the governor's and bishop's palaces, barracks, seminary, lyceum, etc. It is the seat of the provincial government, the bishopric, and the finance department. It has an excellent harbor and the climate is temperate. Here there is a fiscal bureau which regulates the production and sale of opium. The principal trade of this province consists in crude opium, sandal and camphor woods, tea, cinnamon, corn, and silk fabrics; these are exported on a large scale.

Timor.—Population, 7,000 inhabitants. Timor is an island 8 deg. 52 min. north latitude and 134 deg. 46 min. longitude east of Lisbon. It has several harbors, the principal one being that of Babam, affording shelter for a considerable fleet. The climate is very hot and unhealthy; the flora, abundant and luxuriant. In the interior are mines of iron, copper, sulphur, coal and petroleum. Timor forms, with the island of Pulo-Cambing, the district of Timor, which constitutes a subordinate government. It produces corn, cocoa, rice, wheat, coffee, beans and tobacco. It exports wax, coffee, corn, buffaloes, horses and sandalwood. The capital is Dilly, situated on the northeast coast, and contains a fortress of stone, three churches and the residence of the governor. This unhealthy place is traversed by two rivers—the Ahay and the Cebo. The harbor is a most excellent one.

* One milreis at par being equal to $1.08 in United States currency.

PORTUGUESE COLONIES IN AFRICA.

Province of Cape Verde.

Island of San Thiago.—Situated in latitude 14 deg. 54 min. north and longitude 14 deg. 27 min. west of Lisbon. This island is more than 12 leagues in length and 6 leagues in breadth, and is the largest of the group. It is mountainous. All along the shore it is unhealthy, especially in the city of Praia, the chief town of the province. On the hills, at an elevation of upward of 2,000 feet, it is more salubrious. The island produces maize, beans, manioc, tobacco, rum, cane sugar, sweet potatoes, coffee, and fine oranges. Its principal harbors are those of Praia and Tarrafal. It is divided into two districts—that of Praia, whose chief town bears the same name, and that of St. Catharine, whose chief town is Villa Maria, in Tarrafal. The island of Maio belongs to the district of Praia. Population, 6,000 inhabitants. The city of Praia has some fine streets and squares, and edifices of some importance. The constitution of the district dates from a period prior to 1652.

Island of Fogo.—This lies in latitude 14 deg. 45 min. north and longitude 15 deg. 11 min. west of Lisbon. It is 15 miles long and 14 miles broad. Its only port for vessels is that of Nossa Senhora da Luz. The island is mountainous and very fertile, producing corn, beans, manioc, rum, sugar, tobacco, and excellent coffee. The breeding of horned cattle and goats is also carried on. One of the mountain peaks reaches the height of 10,000 feet, its summit forming the crater of an extinct volcano. This island constitutes a township or ward, the chief town of which is Villa de San Filippe.

Brava Island.—Lies in latitude 14 deg. 46 min. north and longitude 15 deg. 35 min. west of Lisbon. It measures 7 miles in length and 6 miles in its greatest breadth. It is mountainous, picturesque, and, in proportion to its area, the most populous of the Cape Verde Islands. Its climate is excellent, and it produces all the corn and other products yielded by the other islands of the group. Chief town, San Joao Baptiste.

Island of Maio.—In latitude 15 deg. 6 min. north and longitude 14 deg. 9 min. west of Lisbon. This island is 14 miles in length and 6 miles in breadth, and is nearly level. It has one extensive natural salt spring and also artificial ones. There is considerable pasturage for cattle, which is turned to account. The sea in this locality abounds with fish. The principal harbor is Porto Inglez.

Island of St. Vincent.—In latitude 16 deg. 54 min. north and longitude 15 deg. 56 min. west of Lisbon. It is 25 kilometers (15.5 miles) in length, and 20 kilometers (12 miles) in breadth. It is destitute of trees and but slightly cultivated. It has a splendid harbor—the Porto Grande—the best in the Cape Verde Archipelago. In the town of Mindello, there is an extensive reservoir serving for the water supply of the town and that of the vessels entering the port. The principal trade in this island is in coal supplied to steam vessels. Population of the island, 7,000 souls.

Island of Santo Antao.—Situation, latitude 17 deg. 11 min. north and longitude 15 deg. 59 min. west of Lisbon. Next to St. Thiago, it is the largest and most productive of the Cape Verde group. It measures 10 leagues in length and 6 leagues in breadth, and is very mountainous. It is abundantly supplied with water of good quality and possesses some mineral springs. The climate is excellent. It produces principally maize, beans, manioc, rum, sugar, tobacco, and excellent coffee, the cultivation of which has been considerably developed during the last few years. The most frequented harbors of this island are Ponta do Sol, Paul, and Carvoeiros. The head of the district is Villa Maria Pia.

Island of San Nicolau (St. Nicholas.)—Situation, latitude 16 deg. 36 min. north and longitude 14 deg. 49 min. west of Lisbon. It is 8 leagues long and 3 leagues in average breadth and contains an area of 115 square miles. It is very mountainous. Its principal harbor is Porto Velho. Together with the island of Santa Luzia, it forms a district, the head of which is the town of Ribeira Brava, one of the most populous places in the Cape Verde group. This island produces maize, beans, manioc, rum, sugar, tobacco, and a little coffee.

Island of Santa Luzia.—Lies in latitude 16 deg. 46 min. north and longitude 15 deg. 48 min. west of Lisbon; measures 2 leagues in length and half a league in breadth. This island is for the most part leased to the merchant Cesar Augusto Neves, who turns the pasturage to account for the rearing of cattle and goats. It is inhabited by from fifteen to twenty persons, who are servants of the proprietor. The island forms part of the district of St. Nicholas.

Island of Boa Vista.—Situated in latitude 16 deg. 7 min. north and longitude 13 deg. 31 min. west of Lisbon. It measures 16 to 17 miles from north to south and 19 miles from east to west. Its principal harbor is Sal-Rei. The climate is tolerably good. In this island are salt, lime, and earthenware factories, and soap works employing an indigenous, oleaginous plant (purgueira). It possesses pasture land serving for the grazing of horned cattle, horses and goats. It forms a district of which the borough of Sal-Rei is the head.

Ilha (Island) do Sal.—Lies in latitude 16 deg. 53 min. north and longitude 13 deg. 46 min. west of Lisbon. It is 18 miles in length and 8 miles in its greatest breadth. The land is level and very barren. In this island a large quantity of salt is prepared, this branch of industry having been considerably extended these last few years. On the coast a good deal of fish is caught, and a fisheries company has been formed. The island forms part of the district of Santa Maria.

Island of San Thome, West Africa.

The island of San Thomé lies in latitude 0 deg. 23 min. north and longitude 15 deg. 50 min. east of the meridian of Lisbon. It is 10 leagues in length, 6 leagues in its greatest breadth and incloses an area of 360 square miles or thereabout. It is very hilly and picturesque. The highest point is the peak of San Thomé, at an elevation of over 6,000 feet. It is traversed by many streams. Its principal harbor is the Bay of Anna Chaves, where stands the town of San Thomé. Population, 30,000 inhabitants. The climate in former times unhealthy, is now very tolerable for Europeans, owing to sanitary improvements in the town and other important measures taken. There are now, in consequence, persons who have been permanent residents in this island for the last fifteen years or more and in the enjoyment of good health.

The produce most cultivated is coffee, cocoa, and quinine. Experiments were made in the way of plantations of cinnamon, india-rubber (caoutchouc) trees, etc., but the results, though good, did not satisfy agriculturists for the most part. The timber grown in the forest of San Thomé is for the most part of excellent quality both for building purposes and for cabinet making. Only about half of the island is under cultivation.

Province of Angola.

The district of Loanda comprises twenty parishes, the chief town being Loanda city, which is one of the handsomest in Africa, built in the form of an amphitheater overlooking the harbor. The city is naturally divided into the upper and lower towns.

Alto Dande.—This parish was formerly one of the most considerable of the province, but suffered much from the revolt of the Dembos in 1772. Lately, however, it has come to form a nucleus of commerce and agriculture. It abounds in palms, orange trees, bananas, mango trees, and a great variety of fruits. At one time the people were most actively employed in the cultivation of beans, manioc, and corn; at present, however, its principal industry is in the plantations of sugar cane, which is considered lucrative. The most important trade in the province is in coffee, which is of the best quality. The inhabitants number about 7,221 and may be subdivided as follows; Europeans, 229; natives, 6,998, of whom 1,875 can read.

Parish of Ambriz.—The commercial houses existing here at the time of the occupation of the place in 1855 were built on the shore, but the violent action of the sea compelled the owners to establish themselves where the town now stands. At present, only the custom-house and a few old warehouses are to be found on the beach, where they are often threatened by the waves. At the northeastern extremity of the territory is a light-house in longitude 13 deg. 7 min. east of Greenwich and latitude 7 deg. 49 min. south. At the southwestern end of the place is the fortress. There are good barracks for the soldiers of the detachment, a residence for the commandant, storehouses, kitchen and prisons. Ambriz, which in 1861 counted only 914 inhabitants, increased extraordinarily in population during the ten succeeding years, numbering, in 1871, 2,115 persons. The population in 1894 amounted to only 1,176 inhabitants.

District of Benguela.—This district is divided into six parishes. The chief town is San Felippe de Benguela, standing on low, marshy ground near the sea, to the eastward of the Bay of Santo Antonio, in 12 deg. 29 min. south latitude and 22 deg. 36 min. longitude. The exports consist of wax, ivory, gum copal, sulphur, hides, palm oil, cattle and other products. The plan has been approved for a railway to Sahona, 14 kilometers (8.6 miles) in extent, to be made by contract.

District of Mossamedes.—Divided into seven parishes. The chief town is Mossamedes, with a population of 6,500 inhabitants, forming, like Benguela, a subordinate government.

Parish of Porto Alexander.—The headquarters of this parish are in latitude 15 deg. 94 min. north and longitude 11 deg. 56 min. east of Greenwich. This territory comprises the seacoast from Cape Negro to the mouth of the River Cumene, north of Cape Frio. It was raised to the category of a parish in 1895. It had been a dependency of the parish of Mossamedes, so created in 1894. It was in 1860 that the first Europeans settled in the Bay of Porto Alexander. Its present population amounts to 1,786 inhabitants, 371 being Europeans.

Province of Mozambique.

The city of Mozambique, situated on the island of the same name, possesses some buildings worthy of note. The principal ones are the governor's mansion, the hospital, the district church, the convent of St. Domingo, the finance department, the town hall, the custom house, and a good marine arsenal; population, 350,000 inhabitants.

District of Cape Delgado.—This district comprises the archipelago of Quizambo and the territories on the mainland denominated Machimba, Pangane, Lumbo, Quissanga, Montepes, Arimba, and the colony of Pemba. The district imports wine, cotton fabrics and woolen cloths; the exports are ivory, amber, manna, vegetable oil, tortoise shell and seashells; number of inhabitants, 5,636, including slaves. The government's head bureau for the district is on the island of Ibo, which is two leagues in length and one league in breadth. There is a strong fortress in this island.

The Mozambique Company.—The territory whose administration and exploration was granted and transferred to the Mozambique Company by decrees, having all the force of laws, issued on February 11 and July 30, 1891, and on December 22, 1893, is bounded on the north by the river Zambezi from its southernmost mouth to its junction with the river Luenha; on the west, by the frontier of the province of Mozambique, in the part comprised between the rivers Luenha and Limpopo, and by this latter river at the point where it is intersected by the meridian 33 deg. and the parallel 22 deg., and onward by this parallel till the coast is reached, the necessary inflections, however, being made in order to avoid dividing the lands of one and the same chief, and so that the areas so acquired by the company, or delivered up by it to the government, may be, as far as possible, equivalents; on the east, the territory is bounded by the ocean.

Quilimane (or Kilimane). Mozambique.—This territory is bounded on the north by the river Quizambo, on the south by the Zambezi, and on the west by the

river Chire. It numbers more than 10,000 inhabitants. The chief town is Quilimane City, built on the northern bank of the delta of the Zambezi. The climate of this place is unhealthy, but the surrounding country is very fertile. It possesses a shipbuilding yard.

District of Tete.—This extensive territory is bounded on the north by the river Arnangua and on the south by the Fura Mountains. It is a military station, the headquarters of which are in the town of Tete, built on the right bank of the Zambezi. In the district of Tete there are iron and copper mines.

Lourenco Marquez.

This is bounded on the south by the province of Mozambique and on the west by the Transvaal. The city of Lourenço Marquez, now the capital of Portuguese East Africa, with its excellent harbor and prominent geographical position, is destined to become the Liverpool of South Africa when the improvements are carried out which it needs in order to afford to commerce all facilities and conveniences for the loading, unloading and conveyance of produce and merchandise. Its possesses a garden kept in good order, and buildings adequate for court of justice, municipal chamber, parish offices, etc. The number of private residences worthy of note is now great, and when the maritime works and sanitary arrangements so needful are all completed Lourenço Marquez will be, perhaps, the most important commercial center of South Africa. In 1900, the white inhabitants numbered 4,900 persons and the colored population 10,000. There are numerous commercial houses, both Portuguese and foreign. Since the 1st of November, 1900, the new beacon light at Ponta da Barra has been in operation. This light is of the third class, with a range of fifteen miles, illuminating a sector of 200 deg., comprised between 15 deg. southeast and 45 deg. northwest. The light is white and fixed, except that every thirty seconds it flashes, and for the time is partially eclipsed. It is collocated on a tower of stone painted white, 9½ meters high, the cupola being painted green. Its bearings are latitude 23 deg. 45 min. 18 sec. south and longitude 35 deg. 32 min. 41 sec. east of Greenwich. There is a line of railway connecting Lourenço Marquez with Komatipoort and Barberton, and one also between Lourenço Marquez, Pretoria and Johannesburg.

THE KINCAID LOCOMOTIVE STOKER.*

One of the late inventions designed for railway use which gives promise of future utility is the Kincaid locomotive stoker, a device being manufactured by the Day-Kincaid Stoker Company, of Cincinnati, Ohio. The originator of the machine is Mr. John W. Kincaid, a locomotive engineer of much practical experience. After years of patient toil, many discouragements and many costly experiments, he perfected a stoker which, it is said, will add to the efficiency of the locomotive service, effect great economies in coal, abate the black smoke nuisance, reduce the cost of repairs in the firebox and enable the fireman to keep up plenty of steam on the largest locomotives with substantially less labor than is required for hand-firing.

As will be seen from the illustrations here presented, the stoker is a very compact little machine. When in service, it occupies the deck of the engine directly in front of the furnace door, but leaves plenty of room for the engineer and fireman. It is applied to the firebox by simply removing the door and substituting the one attached to the stoker. The door is held in position by lugs on either side. When the steam connections are made so as to feed steam to the stoker engine, the machine is ready for use. It can be attached or removed in a few minutes.

The machine consists of four principal parts: A hopper, *A*; a trough, *B*; a stoker engine cylinder, *C*, with its steam valves, *D*; and a controlling engine, *F*. (Fig. 1.)

The hopper, *A*, the lower part of which is in the form of two semi-cylindrical channels in each of which is a spiral conveyor, whose shafts, a_2, (Fig. 4), are journaled in its front and rear ends; and an upper part, which is formed into a convenient shape to hold the coal. This whole hopper is arranged so that it hinges on the journals of one conveyor shaft, a_2, so that the whole may be swung over to one side and out of the way (Fig. 2), should it be necessary when the engine is standing in the round-house for the hostler to put in fire with a scoop through the opening or small door, b_3, in furnace door *E* above the trough, *B*. The bearings for this conveyor shaft upon which the hopper hinges are parts of brackets bolted to the stoker cylinder, *C*, and to the trough, *B*.

The twin spiral conveyors (Fig. 4) keep feeding the fuel toward the forward end of the hopper, whence it passes through an opening, *a* (Fig. 2), in its bottom, falling in the trough, *B*, in front of the plunger, *b*, unless the plunger is extended in process of delivering the previous charge of coal to the furnace (Fig. 2), in which case the coal falls upon an apron, b_3, (Figs. 2 and 3), which is attached to the plunger, *b*, and reciprocates in space between the hopper, *A*, and cylinder, *C*, of the main engine for the purpose of closing the hole, *a* (Fig. 2), to prevent coal from falling behind the plunger head. When the piston is retracted (Fig. 2) carrying the plunger, *b*, at its end, and the apron, b_3, which is secured to this plunger, *b*, the coal drops into the trough or channel, *B*, and is carried forward into the furnace on its next stroke. The trough has a small opening, b_1, (Figs. 1 and 2) in its bottom at the end nearest the cylinder, *C*, through which any dust which may accumulate behind the plunger is discharged.

Integral with the rear head of cylinder, *C*, is formed the valve-chest, *H*, of the controlling engine, *F* (Figs. 1 and 2). This controlling engine, *F*, is placed with its line of action vertical, and has on the upper end of its piston-rod, *g* (Fig. 2), a crosshead, g_1, which operates two ratchet levers, g_2 and g_3, pivoted on conveyor shafts, a_2. On the rear face of the crosshead, g_1, is a projecting lug arranged to operate the stem of the small controlling valve, h_1, through two adjustable collars, h_3 and h_4, which it engages on its upward and downward strokes respectively, moving the controlling valve to admit the steam to the proper end of the floating-valve, h_2, which in turn, admits steam to the proper end of the cylinder, *F*. In this manner the conveyors are moved intermittently by the controlling engine, each downward stroke of the controlling engine moving the conveyors one or two teeth of the ratchets, g_4 and g_5.

On the shaft of the conveyor, a_2 (Figs. 3 and 4), and immediately in front of rachet, g_5, is a series of cams. These cams operate levers immediately behind them and not shown in views. These levers communicate action to the valves which control the velocities of the different strokes of the plunger. On the left side of the steam-chest, *D*, are arranged three small throttle valves, d_1, d_2, and d_3 (Figs. 1 and 2). As the conveyor revolves it opens these valves consecutively, first for light stroke of the plunger, throwing the coal near the door, second for a stroke of medium speed, distributing the coal in the middle of the furnace, and third, giving the stroke of greatest velocity, sending the coal to the forward end of the furnace. By this arrangement of valves, it is easy to control the firing of the machine, first by regulating the speed of the controlling engine, *F*, and thus the amount of coal delivered to the furnace in a given time. Should the fire bank in any portion of the furnace, the distribution of the coal may be changed at will by varying the effective port openings by means of the three throttle valves, d_1, d_2, and d_3, before mentioned (Figs. 1 and 2). The machine carries two lugs, *b*, (Fig. 2), which secure it to the furnace door, *E*, but in such a manner that it may be removed and drawn back on the coal heap should it be crippled by any accident, and so allow the furnace to be fired with the scoop in the usual manner, preventing any delay to the train by reason of an accident to the stoker. This connecting operation has been performed a number of times in about one minute. However, the locomotive may be fired by scoop while the stoker remains in position, shown in Fig. 2.

The economic principles incorporated in the construction of the new device are those which experts concede to be correct and in consonance with scientific discoveries. It is unquestionably true that the causes of waste in hand-firing owe their origin and existence to the fact that a sufficiently high temperature is not maintained in the firebox to ignite the carbons and hydro-carbon gases contained in the coal. The constant opening of the furnace door to feed the fire admits each time an inrush of cold air, reducing the temperature of the firebox and causing leaks in the flues and sheets, necessitating endless expense for repairs. This, it is claimed, is entirely obviated by the stoker because it fires with the furnace door closed; there is no inrush of cold air to the firebox and a

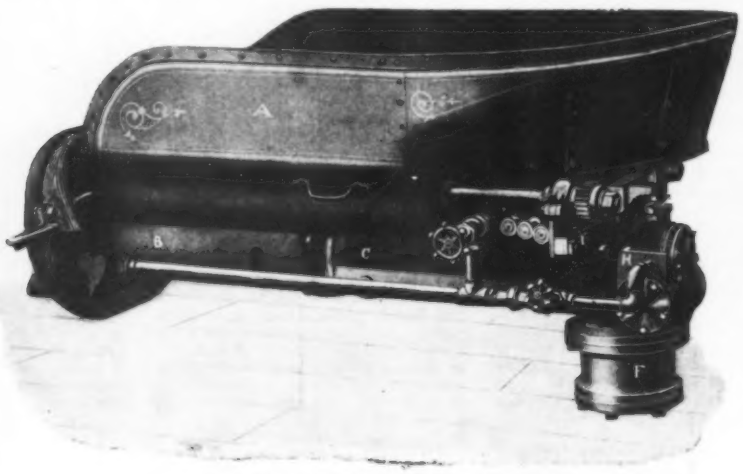


Fig. 1.—STOKER FROM LEFT AND REAR.

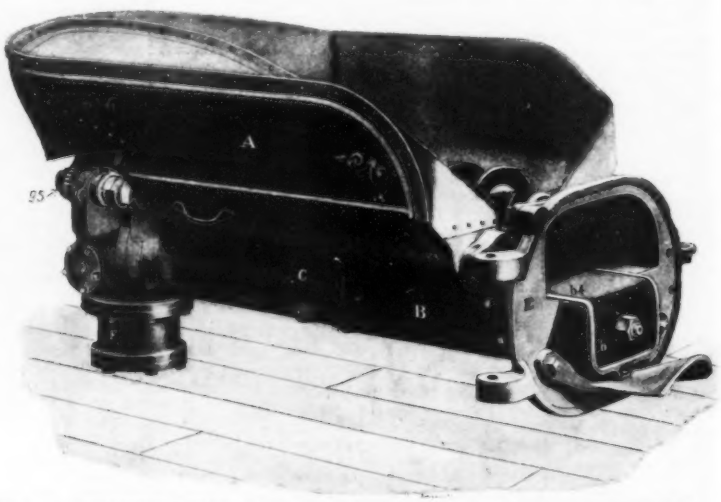


Fig. 2.—STOKER FROM RIGHT SIDE OF INTERIOR OF FIRE-BOX.

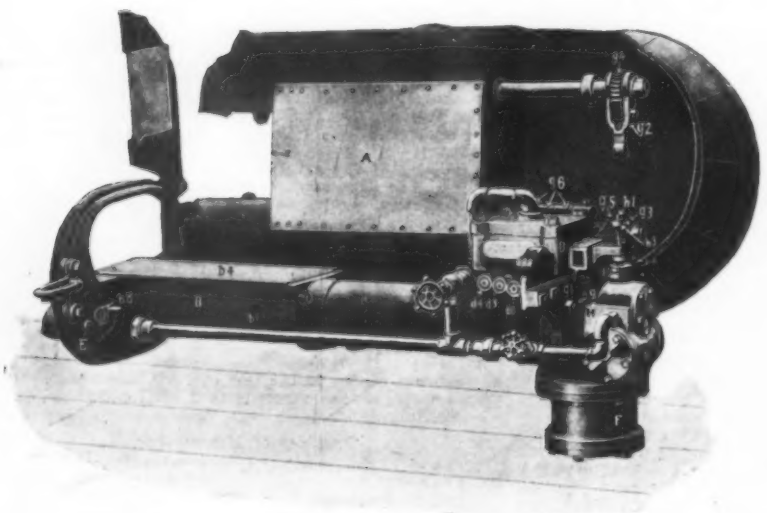


Fig. 3.—HOPPER IS TURNED OVER TO RIGHT, PERMITTING OF FIRING WITH SCOOP BY HOSTLER IN ROUND-HOUSE.

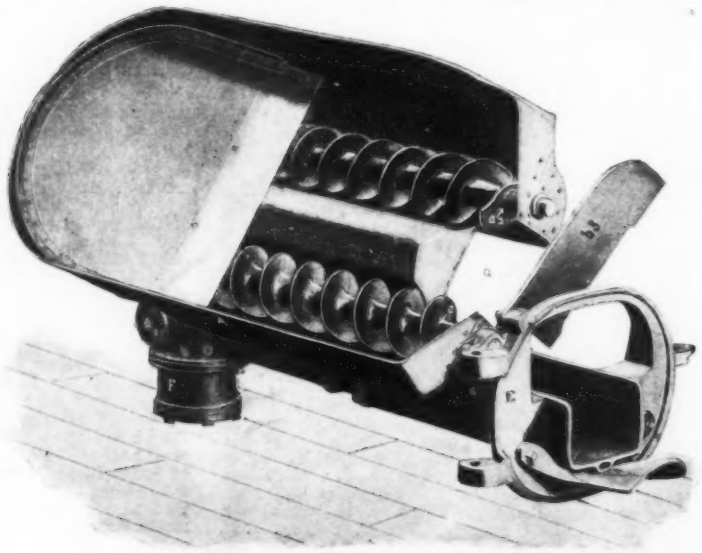


Fig. 4.—THE HOPPER TURNED OVER TO RIGHT.

* Specially prepared for the Scientific American Supplement.

uniformly high temperature is constantly maintained, thus utilizing the valuable heat elements which usually go up the smokestack in black smoke during hand-firing. In other words, it is claimed that the stoker feeds the fire just as the needs of the engine require, scattering the coal thinly and evenly just when and where it is needed, and that it is all burned. Thus perfect combustion is assured, the heat elements are all utilized and there is practically no waste and no black smoke.

INTERNATIONAL ALCOHOL EXPOSITION OF LIGHTING AND HEATING APPARATUS.

THE exposition of lighting and heating by alcohol, at Paris, was installed in the machinery gallery of the Hall of Fêtes, which, by means of an opaque curtain, was converted into an immense dark-room. It was thus possible to present methods of intensive lighting by means of apparatus designed for the illumination of wide external surfaces, while all the domestic apparatus were grouped around handsomely decorated stands. The lighting apparatus were tested at the Conservatory of Arts and Trades in M. Ville's laboratory, while the heating apparatus were tested under the direction of MM. Grouvelle, Lindet and Villard, and the liquids employed were studied from a chemical standpoint by M. Trillat. We shall speak briefly of the apparatus that obtained the highest awards.

Lighting Apparatus.—There are two classes of these apparatus, one embracing intensive lamps designed for the most part for use out of doors, and the other domestic lamps designed for lighting the interior of dwellings. In the first class, it will suffice to mention the improvements made in the apparatus described last year. The new arrangements for regulating the air in the "Washington" and "Kornfeld" lamps have permitted of obtaining the extremely low consumption of 300 grammes of 50 per cent carbureted alcohol for an intensity of 570 candle-power per hour, or 5.26 grammes per carcel-hour. M. Denayrouse has devised some new arrangements that permit of automatically maintaining the necessary pressure in his apparatus, and of thus dispensing with the surveillance necessary heretofore.

As regards the "Monopole" and "Stella" lamps exhibited by M. Delamotte, the intensity of these varies from 35 to 140 candle-power according to the type. The arrangement adopted renders the actuation of the lighting and regulating cocks entirely automatic. A large number of such lamps are employed for the lighting of cities, industrial works, railway stations and even barracks.

The domestic lamps are divided into two classes according as the lighting is accomplished by an incandescent mantle or an open-flame burner. Each of these systems has its advantages and disadvantages. The mantle gives a superb light, but is fragile and the lamp takes some time to start. The open flame burner ignites instantaneously and gives a flame somewhat like that of kerosene, but it requires the use of carbureted alcohol, which, unlike denatured alcohol, cannot be procured everywhere. Among the incandescent apparatus the first prize was awarded to MM. Decamps & Co. for their recuperating lamp (Fig. 1), in which either pure or carbureted alcohol is employed. The alcohol is fed through the wicks *D* to the copper vaporizer *A*, placed under the mantle. The burner, *C*, is supplied by a Bunsen burner, *B*, placed beneath it and having its output regulated by means of a needle valve actuated by a regulating button, *E*, of non-conductive material. A small lateral aperture, *F*, permits of the introduction of a ball of asbestos saturated with alcohol for the starting of the vaporization at the moment of lighting. With a slight modification of the tip, it is possible, in the Decamps lamps, to burn carbureted alcohol (Alcoho-Stellane), which gives much more light than pure alcohol, with about one-half the consumption per unit of light.

Along with the Decamps burner must be mentioned those of the Continentale Nouvelle and of M. Denayrouse, which were described last year. The types of 1902 present some improvements of detail which render their operation more practical while at the same time reducing the consumption. This latter, in the Denayrouse lamps has been reduced to 1.1 grammes of pure alcohol per candle-power-hour, or one-third of the consumption that was general three years ago at the advent of alcohol lamps; and this, taken in connection with the drop in the price of alcohol, permits us to say that the expense of the unit of light is now one-ninth of what it was in 1899.

A large number of alcohol burners have given good economic results, and, among them, may be mentioned those of the "Hantz," "Regina," "Helios" and "Eliot" lamps. Special mention should be made of the "Landi" burner, the practical arrangements of which gained for it the medal of the Touring Club of France designed as a reward for an apparatus that should permit of the substitution of alcohol lamps for the kerosene ones that are employed in inns. Notice should be taken also, of the "Sol" lamp designed for magic lanterns and the intensity of the light of which may reach 100 candle-power even with the use of a very small sized mantle.

Among the open flame apparatus may be mentioned the expanding-disk lamps of the Chalmel system, which, with a special carbureted alcohol called Alkolumine, give a light quite analogous to that of improved kerosene burners.

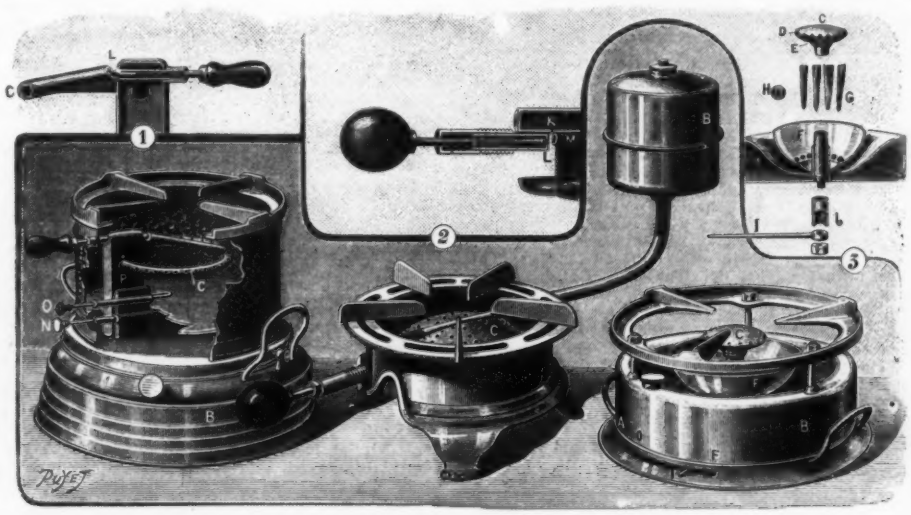


FIG. 3.—POLO, FLOQUET AND PIERRE STOVES.

Heating Apparatus.—These apparatus comprise two classes: stoves and industrial apparatus. Among the former, the apparatus that obtained the gold medal was the one exhibited by the Continentale Nouvelle (Fig. 2). It is an apartment stove supplied by three circular flame burners. A double circulation of the products of combustion causes them to become separated and pass off through the stove pipe at a relatively low temperature after having heated the air of the room as well as a vaporizer placed in the upper part of the apparatus.

The majority of manufacturers convert their kitchen stove into an apartment one by simply adding an upper cylindrical sheet iron body in which the heating of the air is effected but which has no pipe to carry off the gases.

As regards apparatus of the gas stove type, it is impossible to describe all those that received prizes; we shall mention simply those of Barbier, Denayrouse, Decamps, Delamotte, Desvignes, etc. Let us say that in all these apparatus the alcohol is converted into vapor before being burned in order to produce heat. The alcohol may be fed upwardly, downwardly or through communicating vessels. Each of these systems presents advantages and disadvantages. The Polo stove (Fig. 3, No. 1).—The vaporizer is supplied by wicks, *P*, which draw up the alcohol from the reservoir in the bottom. A small supplementary wick (button *N*) serves to set the apparatus in operation by first heating the vaporizing coil. This wick is afterward extinguished and concealed in its sheath, which is closed by a horizontal trap, *O*. An ejector valve, *L*, represented in the upper part of the diagram, regulates the discharge of the circle of burners, *C*. Below the latter, a white enameled disk of iron plate serves as a heat reflector. The Floquet stove (Fig. 3, No. 2).—This stove is supplied by a gravity feed, the reservoir, *B*, being above it. The vaporization is effected in a tube, *K*, which traverses the flame of the burners. The alcohol vapor mixes with air in the ejector, *M*, and is afterward sent into a central reservoir, *C*, which in its upper part, is perforated with burner apertures. As may be seen in the detail diagram, a certain position of the cock allows alcohol to run into the outer cup or trough, where it is burned to heat the vaporizing tube at the start. The Pierre stove (Fig. 3, No. 3).—In this apparatus, the alcohol reservoir, *B*, is circular and supplies the central burner through communicating passages, with the aid of four metal brushes, *G*, housed in the cells of the central tube. The burner vaporizer, *C*, carries at its upper part the heating ring, and, at its lower a second circle of flames which assures the vaporization and, at the same time, aids in the heating. A heat reflector, *F*, of polished copper prevents the heating of the reservoir. A very ingeniously arranged handle, *I*, permits of the regulation of the discharge of alcohol and the flame according to the position of the handle between the points *O* (open) and *F* (closed). The handle can be pushed beyond the point *O* by compressing on opposing spring; and, when it reaches the point *A*, it opens a direct outlet of alcohol for the supply of the igniting cup. The effect of this ingenious arrangement is to prevent the outflow of too large a quantity of alcohol, which might prove dangerous at the time of igniting. Industrial Apparatus.—This class embraces apparatus for brazing and soldering, blowpipes, laboratory furnaces, smoothing irons, etc. In Fig. 4, we give a sectional view of a brazing blowpipe manufactured by MM. Fouilloud & Co. In a reservoir, *A*, placed upon the floor is stored the carbureted alcohol, above which a pressure is created by the pump *B*. This pressure forces the liquid up through the tube, *C*, a regulating cock and rubber tube, *D*, into the burner, *E*. A double needle valve, actuated by the handle, *F*, permits of regulating the proportion of air and alcohol gas according to the temperature and nature of the flame desired.

Upon the whole, this competition and exposition showed that the French manufacturers had for several months past been making great efforts. They were encouraged in their difficult task by the Minister of Agriculture, who has succeeded in interesting the public in the cause of alcohol, and by the public itself, which is daily becoming converted to the use of this new fuel.—Translated for the SCIENTIFIC AMERICAN SUPPLEMENT from La Nature.

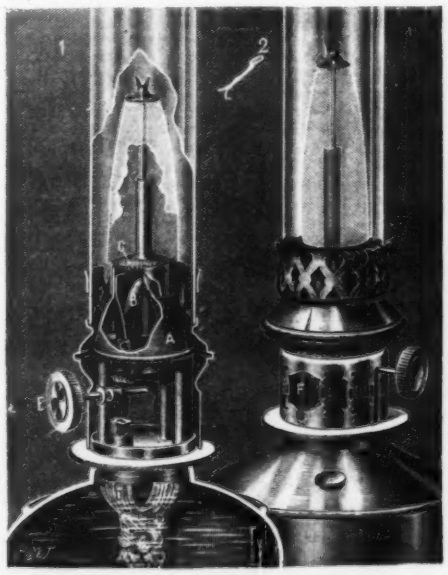


FIG. 1.—DECAMPS & CO.'S LAMP (SECTION).

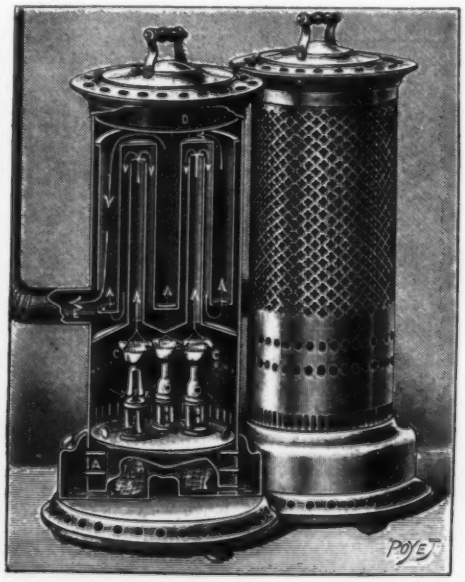


FIG. 2.—CONTINENTALE NOUVELLE STOVE.

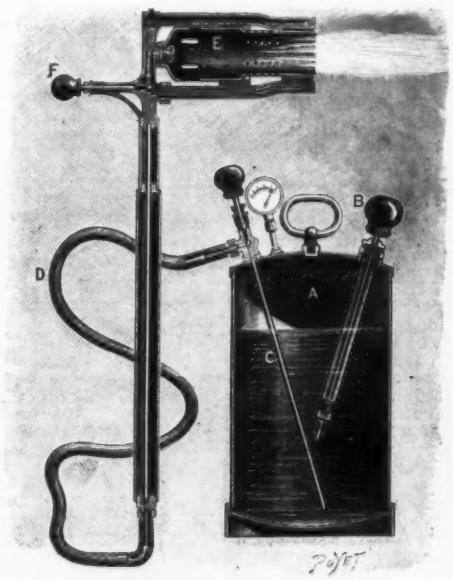


FIG. 4.—FOUILLOUD BRAZING APPARATUS.

GERMAN PROCESSES AND MACHINERY FOR BRIQUETTE MANUFACTURE.

THERE were in operation in Germany at the close of 1900 eighty-nine manufactories of fuel briquettes, some of which—for example, the "Hercules," the "Seven Planets," and the "Tiefbau," at Dalhausen, on the Ruhr—produce each more than 100,000 tons annually. Briquette works are divided in respect to the material employed into two general classes, viz., those which make briquettes from brown coal (lignite) or carbonized peat, with or without the addition of a bituminous matrix or binder, and, second, those which use as a basic material coal dust or slack—the waste of soft-coal mines. Of the latter class, Messrs. Franz Haniel & Co., of Ruhrort on the Rhine, who have works at several points along the Rhine, are representatives. The great Gruhl establishment at Brühl, the "Donatus" works at Liblar, near Cologne, and the Thuringian Aktiengesellschaft, at Deuben, near Halle, are typical examples of factories which make briquettes from brown coal, which is abundant and cheap in many sections of Germany. In the last-named establishment no matrix or binder is used. The lignite is crushed, moistened with water to the consistency of mortar, then passed through the machine, which, by compression under heat, develops the bitumen in the material and renders the mass so plastic and adhesive that it molds rapidly into smooth glistening briquettes of a black or dark-brown color, which are practically smokeless and leave after combustion a reddish-brown ash. All processes of this kind are based upon the fact that lignite is a vegetable coal of more recent formation and, therefore, less perfectly carbonized structure than anthracite or bituminous coals, has lower caloric value, and requires to be compressed and further carbonized by artificial means. Turf or peat is a still more recent formation, and requires proportionately more artificial preparation to produce a high-class fuel; hence the several more or less successful patented processes for carbonizing peat into so-called peat coal, an artificial product which can be either used in irregular lumps or molded into briquettes.

From what has been previously reported on this subject, it will be apparent that in all that concerns the manufacture of briquettes from brown coal, or from slack and waste of bituminous-coal mines, the processes employed in France and Germany have long passed the experimental stage and become a standard commercial industry. If Americans are really interested in the subject, there is no need that they should risk any large sums of money in uncertain experiments. They have only to study the machinery and methods employed in European countries, compare their crude materials with those found and used here, and they can thus start at the point of technical knowledge which Europeans have reached after many years of experience. When, some ten years ago, the attention of American iron makers was called to the German system of making blast-furnace coke in retort ovens, which saves the valuable volatile elements of the coal, it was thought worth while by certain of them to bring over two car loads of Connellsville coal to be coked as a test by the German process. The complete success of that experiment decided the introduction of the standard German type of coking oven into the United States.

Something similar, it would seem, might profitably be done with the materials which Americans have not yet succeeded in converting into satisfactory briquettes. There are experienced engineers and a dozen manufacturers of briquette-making machinery who would gladly co-operate in these tests, and would furnish machinery adapted to working the material thus technically defined. Upon a basis of such tests, plans and estimates could be obtained for the erection of plants in the United States with specified daily capacity. Among the builders of briquette-making machinery in Germany, the following may be cited as of standard reputation, the first two named being more specially concerned with apparatus for making briquettes from coal dust and slack, while the latter build machinery for briquette making from brown coal and peat: The Düsseldorfer Eisenwerke, A. G., No. 55 Bruch Strasse, Düsseldorf; Schichtemann & Kraemer, Dortmund; Tigler Maschinenbau Gesellschaft, Meiderich-on-Rhine; Röhrig & Koenig, Magdeburg-Ludenburg; Maschinenfabrik Buckau, 82 Schönebecker Strasse, Magdeburg; Zeitzer Maschinenbau Gesellschaft, Zeitz, Saxony; and E. Fietsch & Co., Thurm Strasse, Halle a. S.

It remains to speak of several recently invented and patented processes by which artificial coal or briquettes have been more or less successfully produced from peat by the application of machinery or methods not yet fully established on an industrial basis. Inevitably, a description of such a process must rest to a greater or less extent on the specifications and claims of its inventor, and it will be understood that in the following brief citations, no opinion or estimate is offered of the practical value of the methods described.

The Stauber process for drying moist substances was first brought into prominent notice in connection with peat-coal manufacture in 1901, when the Imperial Testing Station, at Charlottenburg, announced, as the result of experiments made with peat briquettes made by the Stauber system, that they contained 45.14 per cent of fixed carbon, 4.54 per cent hydrogen, 29.34 per cent oxygen, and 9.09 per cent ash, and had a thermal value of 3,806 calories. The Stauber system as thus applied, included a process for rapidly drying the moist peat by means of heated and compressed air within a closed chamber or channel, communicating with conduit pipes in such manner that heated air can be forced through the drying channel and cold air through the outlet pipe, the effect being that the cold air quickly absorbs the hot, saturated air out of the drying chamber and condenses it in the conduit pipes, thus greatly stimulating the process of evaporation by which the peat is dried. Peat in its raw state contains from 70 to 85 per cent of water, and, in the humid climate of northern Europe, is usually a very difficult material to dry. It is claimed for the Stauber method that it reduces the moisture to 18 or 20 per cent quickly, effectively, and, what is important, without changing the chemical composition of the peat or in any way adding to it. The drying machine is in the boiler form (cylindrical), and of a size to conveniently produce 5 tons of dried peat per day. In a large plant, this unit would be simply repeated, as a number of machines can be worked with air currents generated by the same engine. A large plant for working the process is now in course of erection near Königsberg, on the Baltic Sea, and another is already in operation at Ostrach, in Wurttemberg. A sample briquette from the latter establishment, and a sample of coal made from peat prepared by the Stauber process, are transmitted as exhibits with this report.* The peat coal can be used for locomotive or other fuel raw, or it can be coked, and produces a coke wholly free from sulphur and as valuable as charcoal for certain industrial purposes.

Estimates furnished by the company give the cost of a plant capable of turning out 50 tons of peat briquettes per day, as follows:

	Marks.	
Buildings	60,000=	$14,280
Machinery	75,000=	17,850
Steam engine and fixtures	15,000=	3,570
Means of transporting material and product	15,000=	3,570
Total	165,000=	39,270

A second process is that invented by Mr. F. Schülke, of Bach Strasse, Hamburg, the salient feature of which is that the turf or peat used is cleaned of roots, stones, etc., then liquefied by water and pumped through a pipe line several miles to the works, where, as claimed by the inventor, it is leached and converted by heat and pressure into briquettes at a net cost of $2 per ton, or into artificial coal having a thermal value of 6,250 calories at a cost of $2.50 per ton. It is understood that a large plant is in process of erection on the northern coast of Germany for the utilization of this method, but as to the actual condition of the enterprise or the practical value of the process on an industrial scale, no exact information is at hand.

The Schoening-Fritz process for making artificial coal and briquettes by carbonizing dried peat is an elaboration by a German engineer of the system invented by Schoening and used with more or less success at Stamsund, in Norway. The German patent is owned by a corporation known as the Deutsche Torfkohlen Gesellschaft, which has its office in Berlin and a small plant at the suburban town of Halensee, where two machines of small capacity—one worked by hand, the other by power—have been set up for experimental purposes. A collection of samples of artificial coal made by this process is transmitted as exhibit with this report.† They are made from ordinary brown peat, of which there are thousands of square miles of deposits in the United States, and will be found coal black in color, firm in structure, glazed on the surface, clean as wood to handle, easily kindled, and practically smokeless when burned in an ordinary grate or stove. Drs. Brockhoff and Ehrecker, of Magdeburg, who as experts analyzed samples of coal made by this process, reported that it contained 68.03 per cent of fixed carbon, 4.98 per cent of hydrogen, 5.34 per cent of moisture, 19.89 per cent of oxygen, and 1.76 per cent of inorganic ash, and had a thermal value of 6,205 calories. The process consists in compressing dried peat between hot rollers, by which it is simultaneously carbonized and transformed into coal. According to the statement of the inventor, 1 ton (20 cwts.) of dried peat, costing in Germany about 1.60 marks (38 cents) will produce from 12 to 15 cwts. of peat coal. To make 1 ton of coal, the cost is 2.67 marks (63 cents) for dry peat; adding 1 mark for labor, the net cost of material and labor for producing a metric ton of peat coal would be 3.67 marks or 87½ cents. These, be it remembered, are the estimates of the owners of the process, based upon expert tests and laboratory experiments. They are given as notes of progress in the manufacture of artificial fuel in Germany, but they will have a practical interest only when the process has been successfully and continuously worked on a commercial scale.

Of the processes actually employed, the value of which has been fully established by experience, one of the most interesting is that invented by Mr. C. Schlickeysen, of Rixdorf-Berlin, and practically operated there, at Munich, and other places. The peculiar feature of this system is that by it black, dense briquettes of high caloric value are made from peat without the application of heat—simply through the action of kneading and drying.

The raw turf comes up by an endless belt or elevator running in the long sloping trough which leads to the peat bed—for these machines are portable and are generally carried on temporary railway tracks, laid so as to enable the machine to follow the point of excavation as the peat bed is gradually exhausted. From the summit of the elevator, the raw material drops into the machine, where it is cut, torn, kneaded, and compressed into about two-thirds of its original bulk, and delivered at the end of the machine in cubes of any desired size, which are first dried until they lose about two-thirds of their water, when the drying process is generally completed by artificial means. The principle upon which this machine operates depends upon the fact that peat in its natural condition contains about 80 per cent of water, of which four-fifths is held in mechanical suspension between the hairy vegetable fibers of which the peat is composed, while the remaining one-fifth is contained in the fibers themselves, each of which is a minute hollow tube, in which water is held by capillary attraction. In the ordinary process of drying peat, the material is cut into cubes and laid in the air, where most of the water held between the fibers soon leaches out by gravity or evaporates. That which is contained inside the fibers is much more difficult to expel, and for this purpose the fibers must be cut, torn, and, compressed until they give up their liquid contents. Nine cubic feet of raw peat is thus condensed by the machine into 6 cubic feet of prepared peat, which still contains about 40 per cent of water, and this is further dried and compressed into 1 cubic foot of black, dry, fossil-vegetable stone, of about 1.5 specific gravity, which, like the samples herein transmitted, can be sawn, planed, and even polished like cannel coal.

Turf briquettes ordinarily contain about 66 per cent of inflammable elements, the remainder being made up of inorganic ash and water. They are thus inferior as fuel to briquettes made from brown coal, which averages 70 per cent or more of inflammable matter. Both represent in their present form the utmost that science has been able to do, in utilizing inferior and otherwise almost worthless materials to supplement and eke out the insufficient coal supply of European countries. Mention should also be made of the Jebsen process for the electrical manufacture of peat-fuel. The process having been exhaustively described in the SCIENTIFIC AMERICAN for October 11, it is unnecessary to discuss it here.

Berlin. FRANK H. MASON.

* Filed for reference in the Bureau of Foreign Commerce.

† Filed for reference in the Bureau of Foreign Commerce.

[Continued from SUPPLEMENT No. 1398, page 22404.]

THE CHEMICAL FACTOR IN HUMAN PROGRESS.*

By PETER T. AUSTEN, Ph.D., F. C. S., late Professor of Chemistry in Rutgers College and the Brooklyn Polytechnic Institute.

AND still again, chemical analysis showing how all the objects about us are composed of but a few different kinds of matter, how, indeed, we ourselves consist of little more than a dozen elementary forms of matter, compels us to gape in bewilderment at the evolution of a universe, with its endless variety of detail, out of less than a hundred different kinds of matter.

For a number of years chemists have been laboring to produce substances and study their properties. In this way a vast number of compounds have been produced, and the list is now yearly added to at a rate that makes one's head ache. The chemist interests himself chiefly with their chemical and physical properties, and as to their proper position in the particular classes to which they belong. Thousands and thousands of such substances have been created, or discovered, by the chemist, and but a very small number of them have as yet been applied. The study of their physiological properties will afford work for a legion of physiologists. Take ether and chloroform as instances. How hard it is to imagine a time when anesthesia was unknown. Think of being unable to overcome pain! Of course the introduction of these agents met with opposition. Some said it was wrong to prevent pain, as others thought it a sin to use an umbrella because the rain was intended to wet us, or to insure one's life because it was flying in the face of Providence. But in time the clouds of ignorance were dispelled and the world came to know one of the greatest blessings that science has bestowed upon humanity. The pain and suffering that these agents have saved humanity is incalculable. Operations, which years ago would have been regarded as madness, are now, by their use, of common occurrence. There are thousands of substances whose physiological properties have not yet been tested. It may be that among all these substances we may find ones that will directly affect each function and organ in our bodies. Physicians have as yet but barely entered this field of physiological research; and unfortunately their labors are hampered in certain places by the attacks of the so-called Bestarians, who would not permit vivisection. Strange how little compunction these people seem to feel in allowing the results obtained by vivisection to be applied in the treatment of their own families when sick. The law of atonement is nowhere more strikingly exhibited than in scientific research. If certain diseases are to be controlled, their causes discovered, and stamped out, cats and dogs may have to be sacrificed. We may wish all of our friends, all the babies and all of the cats and dogs to live, but like many other things we would like to have, we may have to suffer disappointment. Perhaps, after all, the fair sex is responsible to some extent for the destruction of animals. Think of what an indiscriminate slaughter of birds is continually going on that our fair friends may be able to carry fragments of the remains on their heads.† Even if the tortures ascribed to vivisection existed, they would pale beside the horrors that follow the sportsman. The animals and birds dying in fevered agony of peritonitis and being eaten alive by ants and beetles are fully as heartrending as anything that has been ascribed to vivisection by the wildest imagination.

Look at the advance in our knowledge of the action of disinfectants. And here, again, but an absurdly small number of the vast array of substances at our disposal have been tried. Many diseases are communicated by a kind of seeds, spores or germs. If these seeds can be killed it is impossible for the disease to get a foothold. Just as when the seeds of a plant are killed they will not sprout. The following instance of what can be done in this direction is interesting.

Some years ago the whole city of Detroit was disinfected by Dr. Oscar W. Wight, health officer of that city. All the receiving basins, sewers, etc., were disinfected by copperas, and the atmosphere of the sewers was purified by hanging in the manholes iron pails filled with burning sulphur. In all, the amount of copperas used by officials and citizens was 280,000 pounds. The gaseous disinfection of the sewers requires about three tons of roll brimstone. The total expense for the complete disinfection of the sewers (75,000 pounds of copperas and 6,000 pounds of sulphur), was less than $1,300.

After the first disinfection of the city, there followed a great abatement of diphtheria, and an almost entire cessation of scarlet fever. The second experiment was followed by an almost complete cessation of diphtheria. Some years ago I kept the gutters of New Brunswick, N. J., disinfected with a solution of bromine, and obtained a marked improvement in them. These facts make one stop and ponder. If, then, instead of spending the money of a community in supporting inefficient

* A lecture delivered before the Bridgeport (Conn.) Scientific Society.

† A woman, bearing on her head the stuffed carcass of a bird, once importuned me to sign a petition against vivisection.

officials, ward heelers and political quacks, a portion of it were expended in the systematic purification of the town, the death rate would be decreased; there would be fewer little graves to dig. But think of the astonishment of even a not unusually common council if asked to appropriate, several times a year, a sum of money to buy materials to throw into the sewers. Diphtheria, scarlet fever, and, for all we know, many other diseases, are the punishment of infractions of laws ordained for our benefit. Official cupidity, negligence and ignorance mean more than bankrupt towns, business depression, and loss of confidence. They mean broken hearts and bleak graves. The money received from political deals, or from the sale of a vote, is but poor recompense for the loss of a child. The increase in personal responsibility caused by the increase in scientific knowledge is a vast one. It will be the great lever of the future.

The time is fast coming when the good old-fashioned phrase, "dispensation of Providence," as so often used, will have to be replaced by the more easily understood but less pleasant, although entirely synonymous words, "the effect of ignorance," or "the punishment of incapacity," or again, "the result of neglect," or yet again, "the spew of dishonesty." In fact, the object lessons of Nature are so plain that a philosopher might think them to have been especially designed for the intelligence of an average politician. Take, for instance, the cases at Plymouth. The discharges of a typhoid patient were thrown into a brook, and the brook ran into the reservoir of the town. Soon there were 2,000 cases of typhoid. About the same thing occurred in the village of Lausanne, Switzerland. Such are the object lessons of Nature.

As chemical knowledge advances and chemists analyze minerals and the substances found in plants and animals, determining their relations and properties, classification of many compounds becomes possible. Many substances, exclusive of those found in animals, have been produced by the chemists. Thus ordinary salt is the same substance, whether extracted from seawater or produced by mixing muriatic acid and soda. But the substances found in animals, that is in organized objects, while they were analyzed and their composition accurately determined, were supposed to owe their formation to the action of some mysterious vital power, usually called "vital force." It was assumed, with really no other apparent reason than it had not yet been done, that it could not be possible to make an organic substance artificially. The animal by reason of its mysterious, inherent vital forces must do that.

There is a certain compound called urea which is formed in the animal system, and which in many ways is of extreme importance. It was described in 1773 by Rouelle, and determined in 1790 by Fourcroy and Vauquelin. In every way it was then considered as an organic substance par excellence. In 1828 the great master, Woehler, of Goettingen, made urea artificially by heating ammonium cyanate, and the vast field of organic chemistry was opened to investigators. In 1832 Liebig and Woehler published the results of their labors on benzoic acid and the oil of bitter almonds, letting in a flood of light upon the subject of chemical constitution. The great Berzelius in his excitement proposes to call the new radical "Pröin," from *Proi*, the beginning of the day. Since this time, the truly marvelous structure of organic chemistry has grown at a rate unequaled in the history of the development of any science. I wish there were some way of explaining organic chemistry to the general reader, for it is a wonderfully interesting subject. We can appreciate its results although unable in all cases to follow the methods by which they are obtained.

There have been so many remarkable victories achieved in the field of organic chemistry that it is hard to decide which to mention. Prominent among them are aniline colors. A more uninviting substance than coaltar is not often found, yet in the hands of the chemist it has yielded compounds which, by profound study and skillful manipulation, supply the world with colors surpassing in beauty anything produced by Nature. In a few years a great industry has sprung up, employing thousands of men and an enormous capital; and all this founded on a waste product which manufacturers were once at their wits' end to find means to dispose of.

And, then, to what an extent is the fair sex indebted to the humble chemist! We have given them the wonderful aniline colors, which would put Solomon in all his glory to shame, and compel the peacock to hide his head and his tail in bedazzled desuetude. We can make velvet out of cotton and sealskin out of silk. We can supply perfumes surpassing the distilled refinements of the spices of Araby. We can make artificial blushes, heart palpitations,* inflated rubber bosoms, and alabaster complexions. We can make imitation feathers, or whole birds if necessary, as well as all kinds of floral and animal remnants for personal decoration. We can change raven locks to tresses of glinting gold, or vice versa. We can supply eyes of any shade of color, as well as any number or kind of teeth. In fact, the chemist is to the girl of the epoch what the lamp was to Aladdin—only more so.

Indeed; many of our so-called necessities of life are of quite recent introduction. Sugar, for instance, as late as A. D. 150 was prescribed by Galen as a medicine, and in 1455 was still a rarity. In 1775 all England consumed only 20,000,000 pounds in the course of the year against 20,000,000 hundred weight in 1885. And now comes the new sweet substance, saccharine, which is so sweet that a pinch of it will sweeten a barrel of water.

It is strange to note what a power may be exerted by a chemist working in some small and but little known laboratory. Graebe and Liebermann undertook the study of alizarine, the coloring matter of madder, and soon found out its chemical nature, and were able to produce it artificially from a substance found in coal tar. A manufacture was founded and madder growing is slowly but surely dying out. Lately Baeyer has untangled the complications of indigo blue, and it is now but a matter of time when indigo growing will cease to be an industry. Salicylic acid, formerly a rare and costly product, has become an article of commerce, through the labors of Kolbe, who showed how it could be made cheaply from carbolic acid. And now a nation can send its armies out to battle in a region where rheumatic complaints would cripple them and leave them helpless at the mercy of their foes, had they not this power at their control to subdue these diseases. It is true, the diplomat utilizes to their full worth the powers at his disposal, but it must not be overlooked that the chemist furnishes him with many of his most efficacious agents.

I could go on with a long list of triumphs in organic chemistry and show how much we are indebted to the labors of certain diligent investigators in this field. In the matter of the processes of digestion our knowledge of organic chemistry has enabled us to make important progress in the last years. We are now able to produce many new and valuable forms of food, especially for children and invalids. Thousands of lives are saved every day by the use of chemical foods and the application of chemical discoveries.

Let us glance for a moment at iron and steel. If iron contains even very small amounts of certain substances, as phosphorus, for instance, it has but little value, for its properties are injured. In the last years a young English chemist of the name of Gilchrist Thomas discovered a method by which the phosphorus could be easily removed from iron. This appears to be a simple matter, yet how much it means. Immense deposits of iron ore which could not be used, because they contained phosphorus, became at once of value. The material wealth of the country was immensely increased. The uses of iron and the simplicity of its production were increased. It has been well said that this untitled, almost unknown young man,† has done as much or more for England than all her kings, queens and aristocracy put together have accomplished for her.

And again, now that we are coming to live in an age of steel, note that steel is a chemical industry. To make steel, we must decarbonize iron to a certain point, and to do this economically Bessemer introduced a method which revolutionized the whole industry. Can any one tell what the debt of the world is to cheap steel? Any one who will bear it in mind will find himself giving hundreds of answers to it. Try to trace out for how many of what are called the necessities of daily life we are indebted to cheap steel, and one cannot but be surprised.

The subject of the metals in general is worth attention. Chemistry has brought our means of extracting them from their ores and their subsequent refinement to a remarkable degree of perfection. We have numerous alloys which are of daily service, as phosphorus-bronze, friction-metal, gun-metal, and a thousand other useful inventions, all tending to cheapen articles and, indeed, in many cases to beautify common objects. Compare the doorknobs and hinges tastefully made of bronze with the common ones in use only twenty years ago. This all means the art education of the people, and we must never underestimate the power of this. And now we have cheap aluminium. It looks as if this may be the metal of the future. Brilliant, wonderful in its many properties, and more remarkable still in the fact that every clay-bed is a mine of it. How irritating this has been to chemists for years can well be imagined. Incalculable stores of this beautiful metal all about us and no means to extract it. If aluminium can be modified as iron now is, and given properties akin to wrought iron and steel, then the future will be the age of aluminium.

If one were to ask how the state of civilization of a country should be judged, one would probably be told how many churches there were, attention would be drawn to the volume of business done, the fine hospitals, the excellence of the police, the commodious jail, the tax rate and many other prominent features of the place. The chemist, however, would simply determine the amount of sulphuric acid used, directly or indirectly. In other words, almost all of the articles we use involve either directly or indirectly in their manufacture the use of sulphuric acid. This manufacture is carried on a scale so vast that a fair idea can hardly be given of it. Every detail has been studied and studied by scores of chemists. Each reduction in the cost of making it has cheapened thousands of articles. In the manufacture of bleaching powder there was once a great waste. The acute mind of Walter Weldon turned this loss into a source of profit and the price of chloride of lime was reduced. Every time that we buy a piece of white paper and admire its whiteness and cheapness, we must remember that we are indebted to Walter Weldon.

Indeed, in the matter of paper, note how striking has been the progress. Cheap paper means cheap books, cheap newspapers, cheap knowledge, education of the public. Good paper means preserved eyesight. I need not say that paper is really a chemical manufacture. But little progress would be made in turning wood into paper without the chemist. And note again the future of paper. We have paper car wheels, paper gas pipes, paper water pipes, paper pails, paper stoves, paper chimneys, paper boats, paper forts, etc., etc.

One of the very important results of the study of chemistry has been the gradual change of empirical and wasteful processes of manufacture into rational and profitable methods. Every year shows progress in increasing the yields of manufactured products, and also increase in purity. Wastes are utilized, manufacturing costs are decreased, labor is made more efficient, trade expands and profits increase.

In 1739 Dr. Clayton, Dean of Kildare, first distilled coal. But it was the end of the century before gas was practically introduced as an illuminating agent. Imagine one's sensation on first being asked to put a network of piping into one's house to convey a combustible and poisonous gas. The joints might not be tight, the cocks might leak; we might be poisoned by the thoughtlessness of any one who might not shut them off, or, indeed, the house might be blown to bits should the gas escape and ignite after it had become mixed with air. Yet it does not worry us now, even though all these things do come to pass not infrequently. From Dr. Clayton's experiments has arisen a vast industry with complicated side-branches. Gas, coke, colors, medicines, disinfectants, delicate flavoring essences and a host of other inventions have followed in a steady stream. There has been no end to the discoveries in this field. In Europe gas has become almost a waste product, so valuable have its by-products become.

The invention of artificial light has extended the available term of man's life; by giving the night to his use it has, by the social intercourse it encourages, polished his manners and refined his tastes, perhaps as much as anything has aided in his intellectual progress.

It is very interesting to trace the development of many manufactures, as for instance the introduction and perfection of glass-making, which allows us to avail ourselves of the best medicine there is, sunshine. What a world of happiness lies in that word, "sunshine!" Disease-germs are paralyzed by it. Plenty of it prevents dark deeds. If we ever feel like being thankful, let us remember the abundance of windows in our houses, and that our little ones can play in the sunshine, and that we can have sunshine in our houses free of cost and without tax. How little one realizes the convenience in the use of glass and china articles. That hard, smooth surface which can be so readily cleansed, and which makes our tables so attractive and our food so palatable. We shall find that much of our pleasure, and, indeed, a good deal of our health, is dependent on glass and porcelain. The chemist has done hard work for us on these articles, for there have been many neat chemical problems involved. We can now give glass some valuable properties. We make wool of it, spin it into yarn and weave wonderful dresses of it; make wigs of it, cover steam-pipes and fill floors with it, make railroad sleepers out of it. Perhaps, in time, we shall be able to turn it on a lathe, or even to live in a glass house without fear. Who knows? Does not the illustrious Hofmann say, "With the gods and the chemists all things are possible!"?

There are many interesting applications of chemistry which have been forceful factors in the development of civilization. The manufacture of soap, for instance, the use of which has also been taken as an index of civilization, has been immensely improved by the labors of the chemist, and it would be easy to trace the beneficial effects of it on the health of a nation. It is true that we have not the public baths of the Romans, or places where all of the poor may bathe, but we have the next best thing—cheap soap.

Then there are remarkable chemical improvements in the arts of dyeing and printing textiles, by which good clothing has been made accessible to the poorer classes. Cleanliness and good clothing are no small factors in civilization. There have been astonishing discoveries in the field of fermentation, the middle ground between biology and chemistry, from which our ideas about disease-germs and ptomaine poisons have arisen, and due to which treatment of many diseases has been radically altered for the better. In fact, the whole of antiseptic surgery, which allows of operations never dreamed of in past years, has become not only possible but of daily occurrence. Thousands and thousands of useful lives have been saved by the application of these discoveries.

And so our increasing knowledge of the relations of things will enable us in time to prevent disease. The average death rate in our cities is far too high. The average duration of life is about ten years too short. There are over 100,000 unnecessary deaths every year in the United States. In time we shall see more of true death, Euthanasia, or old age. How well Richardson* describes this: "Without pain, anger or sorrow, the intellectual faculties of the fated man lose their brightness. Ambition ceases or sinks into desire for repose; ideas of time, of space, of duty, languidly pass away. To sleep and not to dream is the pressing, and step by step, and still pressing need, until at length it whiles nearly all the hours. The awakenings are shorter and shorter, painless, careless, happy awakenings to him of a busy world, to the merry sounds of children at play, to the sounds of voices offering aid, to the efforts of talking on simple topics and recalling events that have dwelt longest on the memory, and then again the overpowering sleep. Thus on and on, until at length the animal nature is lost; the intuitive and merely animal functions now no longer required to sustain the higher faculties, in their turn, succumb and fall into inertia. This is death by Nature, and when mankind has learned the truth, when the time shall come—as come it will—that 'there shall be no more an infant of days, nor an old man who hath not filled his days,' this act of death now, as a rule, so dreaded because so premature, shall, arriving only at its appointed hour, suggest no terror, inflict no agony."

Chemistry has even dared to make the study of life a matter of investigation. Dr. Oscar Loew has indicated that in live albumen there is an atomic complex known as the aldehyde group, and in dead albumen it is not present. A striking inference of this fact is that substances which are known to have an energetic action on the aldehyde group exert also an intensely poisonous action on living protoplasm, and certain substances have on this induction been examined and really found to be violent poisons. Could we reconstruct the aldehyde group in a dead protoplasm? And if so would the protoplasm again be alive? Who can say? It is a mysterious subject and the discoveries but make it more mysterious. But then it is darkest before daybreak.†

Even such a little matter as a match represents quite a number of chemical phenomena and ingenious applications of chemical discoveries. It is curious to think of what added power has been given to man by his ability to make fire so easily. The idea of fire leads me to speak of explosives, for there are some very interesting facts to be derived from the study of this subject. If we had time to investigate the effects of gunpowder in history we should note some striking results. Ancient history is largely a history of war. Disputes were settled by force of arms—physical force. Rulers ruled by force. Blood flowed on slight provocation. Might,

* Amyl nitrite has been used for this purpose.

† Walter Weldon.

* Diseases of Modern Life.

† This was written before the announcement of the researches of Loch and Matthews.

not right, was the rule. Weapons were of the crudest kind, and wars often lasted for years. Later on the ruling classes clad themselves in armor and then as McElroy has so well explained in his article on "The Musket as a Social Force," for many years the world was at the mercy of the "Man on Horseback." He was invulnerable in his armor, and with sword and spear tyrannized, brutalized and slaughtered as his humor struck him. The serfs fared badly in the early days. In the "war of the Jacquerie," in 1348, there was an exciting serf-hunt conducted in one of the French towns, and after three weeks over 20,000 miserable men were run to earth and killed. The man who could strike the heaviest blow was ruler in those days.

Then in the fourteenth century someone invented gunpowder, and then a queer sort of gun, a kind of two-inch gaspipe with a touchhole. This gun was fastened to a stick, which one man held, while a second applied the fire. The ball weighed a pound and traveled scarcely two hundred feet, so weak was the powder. Crude as the whole contrivance was, and tedious as it was to fire off, it curled up the man on horseback in the dust and left him a waste product on the land. Those who had robbed the farmer of the fruits of his hard labors, now went to fertilize the crops, a most admirable adjustment of Nature, even though it was somewhat belated. Soon gunpowder and the gun were improved, and by their aid the robbed man "re-clothed himself with the rights that had been torn from him by a thousand years of the despotism of the "Man on Horseback!'"

During the last fifty years explosives have been brought to a high state of perfection. Chemistry has placed in the hands of men agents that are so powerful that they cannot be resisted. Trace the progress of a nation by the record of its conquests, and note how chemistry has given it, perhaps, the majority of its tools, its explosives, its system of feeding, its medicines, and so on through a long list. It will not be long before war will be impossible; in fact all conflicts impossible. The dynamite gun will blow a fort to dust, the submarine boat or the electric torpedo, guided by an unseen hand miles away, will send a ship into the clouds. The balloon, dropping explosives and inflammables, will wipe a city from the face of the earth as a child rubs a picture from a slate. An explosive shell, filled with the proper chemicals, will poison a whole army. The prick of a needle, coated with virus, will sow incurable disease, and you may select from a catalogue nauseatingly long. A gill of typhoid germs dropped into the water reservoir of an ordinary town will leave few to tell of the horrors that followed. War will in time mean simply extermination of both parties. Pure arbitration, intellectual investigation of the question, the discovery of the principles and laws involved in the matter, and careful adjustment must come in time. Oppression, tyranny and bossism are to pass away. Knowledge is the possession of humanity, not of the rich alone, or of the powerful, but it is to be the birthright of the citizen. An irresistible power has been placed in the hands of the oppressed. First we had the slave, then the serf, now it is the wage-worker, the laborer. The capitalist has money, the laborer has dynamite. It is about as hard to know what to do with one as with the other. Neither can ever rule, and this phase, like the preceding ones, will slowly pass away. Any attempt to control others selfishly and wrongfully will be defeated by the irresistible power of knowledge of right.

Look abroad and notice how much nations take from each other without fighting. They slap each other's face and call each other bad names, but they don't fight. It is true that they support immense armies and armaments, but the time is coming when these armaments will cost so much for their support that to avoid bankruptcy they must be given up. The swords must be turned into plowshares and the men must go to work to aid in supporting instead of being supported by others. A peace of nations, a bankruptcy of nations, or an extermination of nations are the three alternatives to-day for Europe. So much Bismarck saw.

Force being neutralized, the conflict is to be one of intellect, reasoning based on an exact knowledge of facts. Physical force is already at a considerable discount. Educated brains are the important factors of success to-day.

EXCAVATIONS IN PALESTINE.

DOCTOR SELLIN, Professor of the Evangelical Theological Faculty in Vienna, has delivered a lecture upon the results of the excavations which he carried out in Palestine for the Vienna Academy of Sciences. While on a visit to the Holy Land some time ago, Dr. Sellin observed a large mound or small hill, which he considered was probably of artificial origin and might conceal the remains of some ruined city. He returned to Vienna and succeeded in obtaining the necessary funds from the Academy of Sciences for excavating the site. The mound in question is situated near the village of Tanaak, one day's journey from Jaffa and three days from Jerusalem. The Sultan granted permission to carry out the work, and Prof. Sellin set out for Palestine again with the necessary equipment, and after some little difficulty with the people of the locality, commenced his excavations on March 9, employing as many as 150 workmen.

The excavations were remarkably fruitful, for under the mound no fewer than four castles or fortresses were discovered. In the center were the ruins of an Arabian castle; on the east, a castle of the period of King Solomon; on the northwest one of the late Israelite period; while on the west was found the earliest of them all, one of pre-Israelite or Canaanite date. All the castles had been plundered before they were destroyed, so that no valuables were found, but objects of stone and clay and weapons were discovered, which assist in fixing the approximate era of the various buildings. The Canaanite castle is the oldest, built of unhewn blocks of stone which show no marks of the chisel. Inside, lay fragments of images such as are mentioned in the Bible, and also a number of small ornaments made of stone, and earthenware, mostly representing beetles, scarabs and other insects, and bearing inscriptions. There were, too, some rude weapons and vessels. Dr. Sellin estimates the date of this castle at about 2,000 B. C. and suggests that it was destroyed by the Israelites, perhaps under Solomon, who proceeded to build their own fortress. Though this second building has also suffered considerably, enough remains to show that it belongs to the so-called Solomon castles. In both, curiously enough, were found idols, vessels, and other objects belonging to religious rites, such as a sacrificial pillar of stone, with an opening for libations, a stone altar, and, the most important find of all, an earthenware altar in the form of a throne, adorned with cherubim and lions. This is the only existing representation of cherubim of that date. They appear as human heads with a lion's body, and wings. The late Israelite castle appears to have been a fortress only. The Arabian castle shows more architectural skill than the others in its arches, etc., and recalls the style of the period of Haroun-al-Rashid. Vessels and lamps were found, and inscriptions of a religious character. Beneath the ruins of all the castles human remains were found buried with vessels bearing inscriptions, while close to the Solomon castle a cemetery for children seems to have existed. Prof. Sellin describes the excavation of the Caananite castle as his chief feat, for though remains of such castles have been previously discovered, none have hitherto been completely laid bare. Most of the objects found have been sent to the Museum in Constantinople, but efforts are to be made to convey some of them to Vienna.

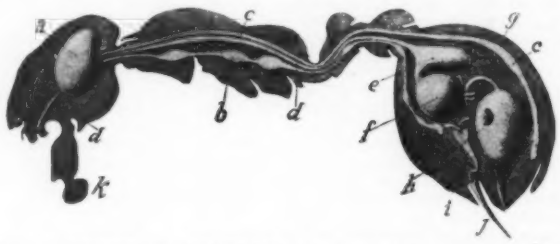


FIG. 1.—GENERAL ANATOMY OF AN ANT. (ACCORDING TO JANET.)

a, Brain; *b*, nervous ganglion; *c*, dorsal vessel (circulatory apparatus); *d d*, œsophagus; *e*, crop; *f*, stomach; *g*, small intestine; *h*, large intestine; *i*, poison reservoir; *j*, sting; *k*, tongue.

THE DESTRUCTION OF ANTS.

ALTHOUGH on account of the care that they bestow on their young, and because of their battles, their pastoral habits, and the custom that some of them have of making slaves, ants have long excited the admiration of observers, they are nevertheless the terror of housekeepers and are very often regarded by cultivators as a genuine scourge.

Aside from a few small species which enter our houses, wherein they sometimes prove very troublesome, and some others which, visiting plant lice, excite the latter to a greater absorption of the sap of plants, ants are essentially carnivorous and consequently useful. Michelet was right when, after enumerating the failings that have been ascribed to them, he finished by saying: 'Their virtue is to destrov everything that might injure men, whether it be an insect or some unwholesome thing." We meet with them everywhere carrying dead or living insects to their abode. Their presence in forests is in nowise injurious, and it is asserted that those that establish their domicile in trees select dead wood in which to hollow out their nests, and, moreover, that the trees which they inhabit are especially preserved from the attack of Scolytidæ. Nevertheless, we are fain to agree that they should be destroyed in cases where they prove troublesome or injurious. The methods that are employed for the attaining of this end are as numerous as they are generally inadequate. A judicious use of them, nevertheless, may be attended with good results; but, before making them known, a few words as to the development of ants will certainly not prove useless.

Ants belong to the order of Hymenoptera, which embraces flies provided with four wings. Those that we see running about are destitute of wings, as they represent the modified female individuals whose entire organization has become adapted to the function of "workers" that they are destined to fulfill concurrently with that of "nurses." At certain moments, the ant-hills contain large numbers of normal individuals males and females, provided with four wings, and which, on some warm, sunny day, take flight in a "swarm." It is the mission of these to perpetuate the species. After the "nuptial flight," the males are killed by the workers because they have become useless. As for the females, some of these are seized by the workers, which pluck off their wings, if the latter have not been lost already, and carry them to the ant-hill where their disposition is to increase the colony. The others, taking refuge in some hole, proceed to lay a bundle of eggs, bury themselves in the ground at the beginning of the inclement season, remain torpid until spring, and then begin to take care of their progeny.

From the egg a larva is hatched that first becomes a nymph and then a perfect insect. The first eggs produce workers and the first insects hatched take the place of the worker in the care of the family. The worker, fed by her offspring, devotes herself thereafter solely to oviposition, and the ant-hill develops very rapidly. The nest, which differs in each species, is enlarged according to requirements. Sometimes it is formed of chambers and galleries excavated in the earth, and sometimes it is located in a hollow tree, a hole in a wall, or under a stone or root. In certain species it is surmounted by a hillock or by twigs, etc.

We cannot in this place enter into the details of the habits of ants, but shall pass on to say that the internal organization of the ant recalls that of bees and other allied insects. Fig. 1 gives a good idea of it. They may be considered injurious, after a manner, by reason of their sting, which, like wasps and bees, they (not the males, of course) carry at the extremity of the abdomen. At the moment of stinging, they inject into the wound the venom of two glands that supply the sting, and the action of which is sometimes very energetic, as in the *Myrmica rubra*, for example. In certain species, *Formica rufa*, among others, the sting has undergone some anatomical modifications. Such species do not sting, but are capable of projecting their venom to a distance of 20 inches. So it is well to approach the large hills of these insects with precaution and to take care to protect the eyes.

As regards getting rid of these pests, the first method that presents itself is the destruction of the entire cluster of ant-hills at one swoop; that is to say, when it is not established in a wall, floor, or other inaccessible place. For nests in the ground, scalding is frequently employed; but this method is generally inadequate, since the water gets cold before reaching the bottom of the nest. It is much better to remove them with a spade. In this case the material collected is placed in a bag and subsequently emptied into boiling water or buried in the earth, which is then compactly rammed down. At this moment, any sort of insecticide may be added. But if there should be any danger of injuring plants, through the cutting of their roots, it will often be well to remove only the top of the nest, and then do the rest of the work by degrees.

It sometimes suffices to ram the nest with a heavy stick, which crushes everything. It is also recommended to plug up the entrance to the nest with lime impregnated with a decoction of colocynth or to moisten the earth with poisonous substances such as a solution of corrosive sublimate, sulphide of carbon, etc. All such means are good, provided they be renewed.

Plowing destroys the nests and renders the ground unfit for the ants to dig holes and throw up their hills.

The larvæ and nymphs are the object of a more spe

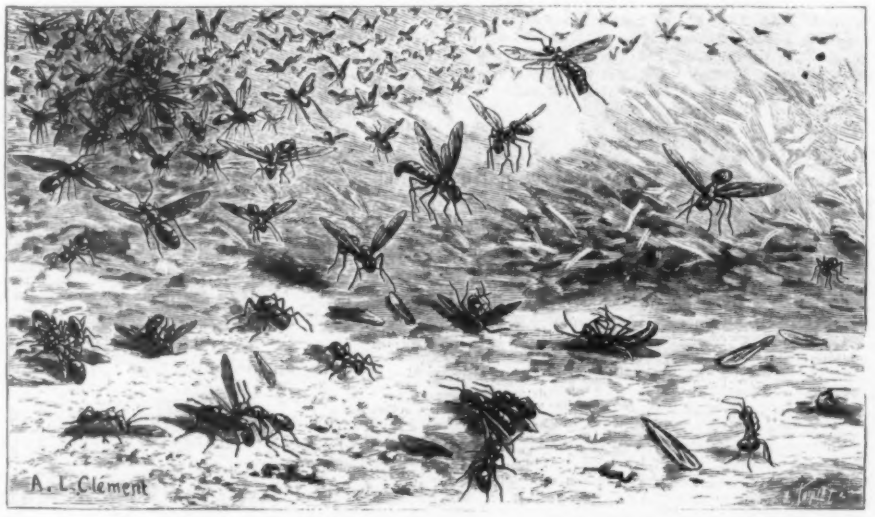


FIG. 3.—SWARM OF ANTS (FORMICA FUSCA.)

cial method of destruction. Under the erroneous name of "ant's eggs," these are indispensable for the rearing of pheasants and various other fowl, and are gathered quite easily. Among the methods employed, is the following: Upon the ground near a large ant-hill, a circular space free from plants and stones is prepared and all around this are arranged inverted flower pots slightly raised by means of a small stone. If flower pots are wanting simply wide leaves may be arranged upon the ground. A large bag is filled with the contents of some ant-hills and emptied in the center of the space thus prepared. The ants, solely occupied with the care of the young, at once carry the latter under the pots or leaves, where it is easy to gather them before the insects have time to carry them to a safe place. It often suffices to invert empty flower pots over the ant-hill in order to permit the insects to assemble all the larvæ and nymphs under them at certain hours of the day.

These are partial means of destruction which are more or less efficacious; but it is outside of the ant-hills principally that we have to wage war against ants, chiefly the house species. Here an endeavor is sometimes made to attract them in order the better to destroy them, or to drive them away by some means or other. A potted plant covered with lice will attract them in large numbers, and so will a flower pot full of earth upon which has been spread a saccharine bait and which is then covered with a tile or a plate. The hole in the bottom should remain free. Paper covered with honey and sponges baited with a mixture of sugar and honey attract many of the insects, which may be afterward killed by immersion in boiling water.

But in most cases it is to the driving away of the pests that all efforts are directed. Every inventor is convinced of the efficiency of his own method, but it must be confessed that up to the present none is infallible. The list of such methods is long, and tne following are some of the substances employed: pyrethrum powder; sifted ashes of wood, paper or cardboard; powdered borax mixed with sugar; charcoal; powdered chalk, or whiting; sawdust; powdered cacao or coffee grounds; and sea salt or powdered sulphur. The action of certain of these substanc , which, for the most part are only efficacious because of their pulverulence, would be difficult to explain.

Other materials that have been recommended certainly act by their odor, for example: phenic acid or benzine; tar or petroleum; a mixture of phenic acid and molasses; fish oil or oil of cade or juniper; spirits of turpentine; snuff moistened with water; a smoked ham bone; a rotten lemon; crushed ants; water in which crawfish have been boiled; water made sour with vinegar, etc.

A large number of plants, such as chervil, parsley, basil, wormwood leaves, lavender, anise leaves, fennel, pyrethrum, lily of the valley, thyme (steeped in vinegar water), are said to drive ants away.

In order to preserve trees it is recommended to provide the trunk with a ring of glue or simply with a wide ring of chalk applied about three feet from the surface of the ground. To preserve seed beds, the advice has been given to spread over them sawdust treated with carbolic acid. An heroic method of getting rid of ants is to blow them up with a train of gunpowder, or to pour over their passageway some rum in which sugar has been dissolved and then set fire to it at the proper moment. The sulphur candle can also be used. Most of these methods are good, but what we would especially recommend is perseverance. Before this infinitely "small ant" that often seems never to weary, unceasing patience will be found necessary. We commend such patience to our readers with the conviction that in it alone lies the secret of success.

Can one see the ingenious ants fetching, grain by grain, the earth which they deposit on some glue or tar, in order to cross it, or, so as to pass a small trench filled with water to bar their passages, see them crowding upon one another and forming a living bridge on which they cross, while hundreds of their fellows drown, without reflecting upon the industry and perseverance of these little creatures?—Translated for the SCIENTIFIC AMERICAN SUPPLEMENT from the French of A. L. Clement, in La Nature.

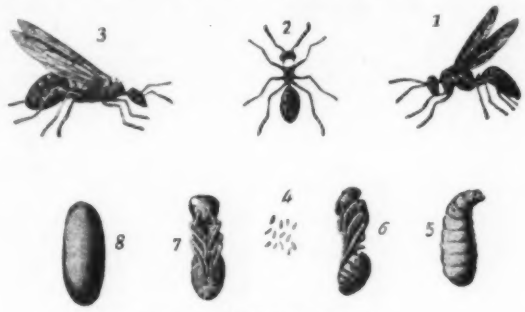


FIG. 2.—FORMICA RUFA.

1, Male; 2, worker; 3, female; 4, eggs; 5, larva; 6, nymph (side view); 7, nymph (ventral view); 8, cocoon. (Figures magnified two diameters.)

SURVEYING IN CENTRAL AMERICA.

ONE of the engineers most actively engaged on the surveys in Central America to furnish information concerning the practicability of various ship canal routes since 1888 is Mr. Boyd Ehle, who has a paper on the problems and methods of the Isthmian canal surveys in the Transactions of the Association of Civil Engineers of Cornell University. The organization of the engineering department had a chief engineer at the head, under whom were division and assistant engineers. The latter were in charge of a party in fieldwork or a section of construction. A survey party had two instrument-men, a level rodman, two chain-men, a cook, helper and about eight machete-men as a minimum. In new country the assistant engineer was supposed to scout the work ahead of the instrumental survey, using hand instruments and perhaps pacing distances. To get the best results a clinometer was used and a chart giving the pacing reduction for various slopes. With a small protractor it was possible to make a map and sketch in the topography. A machete was, of course, the most essential part of the outfit, without which progress was well nigh impossible.

Much valuable information could be easily and quickly secured by these preliminary examinations, and if results justified a detail survey, a compass or transit lines with levels would be run through paths cut by the machete-men and the line cross-sectioned for a considerable distance on each side, so that in case of a probable canal location this could be projected on the map. Usually the fieldwork was mapped out on a scale of 400 feet to an inch and 10 feet contours, but in the more important work at the lock and dam sites, 100 feet or 50 feet to an inch was used. The topography of large tracts was thus developed in order to cover thoroughly the area of comparative feasibility. No comprehensive idea of the whole problem could be secured except from maps, for the fieldwork was somewhat like surveying in the dark, as far as the physical characteristics adjacent to the line were concerned.

There was, however, a great difference in the amount and character of the work of the various assistant engineers, due, Mr. Ehle says, both to method and energy displayed. A certain man seeking out a ridge or canal location would try to make a checker-board survey of the whole country in question and pick out his results on a map, while another would carefully scout out the work on the ground and direct the survey at once to the desired results. The latter was the more valuable man, but it required greater physical energy on his part. Often an assistant engineer simply kept his men at work while he remained in camp, ran the party, and submitted results.

In the surveys of the impounding ridges for the basins it was considered best to determine the general direction and follow that compass course until it ran off the heights into a watercourse, and then offset back up a branch to the divide again and start over.

In a canal survey it is important to get the shortest distance with the least elevations, and this usually led into valleys and swamps where the work was disagreeable, difficult and unhealthy, not to mention the attention of the myriads of mosquitoes and other insect pests. Transit location surveys never averaged one-half mile a day, while compass and cross-section work usually averaged less than 5,000 feet per day, with a maximum of about 8,000 feet per day.

In a river survey, stadia methods were used for fixing the points along the bank, and the soundings located from these by the stadia or sextant. With the sextant the boat was usually run on a range and the soundings taken at time intervals. The line was assumed straight between the sextant observations, which is only possible in still water. With the stadia it is possible to locate each point more quickly and accurately. Stadia or gradient methods were of little use in the forests, and the chain was usually depended on for distances. Triangulation surveys were used on Lake Nicaragua, but were not effective on the San Juan or other rivers on account of the great difficulty of clearing out the overhanging trees along the banks.

In a reconnaissance along the coast of Darien two sextants were used to establish the position and elevation of points on the distant mountain range and the contour sketched. The distance between the observers was determined by observation on the mast of a ship. The results, although somewhat crude, answered the purpose, and were secured very quickly and cheaply.

In the investigation for foundations and classifications of material various methods were used. The earth auger was the most simple and least satisfactory, as it was difficult to manage at any great depths, and when stone was reached it was the limit of the boring and in no wise conclusive that this indicated rock in place.

The Pierce machine, with its facilities for driving, casing and washing up light materials, succeeded the common earth auger. With this when stone was reached it was customary to lower sticks of dynamite and explode them by an electric battery, which usually was sufficient to displace ordinary boulders. If this was not effective the diamond drill was used to get deeper and obtain a core of the material. On the Panama canal deep test pits were used, and even a tunnel to determine the substrata.

The various classifications of material were obtained from samples preserved by the boring foreman in small bottles if earth, or of rock by taking a section of the core. These were labeled with the location of the hole and depth in feet at which they were taken, and shipped to headquarters for use in classifying the material on the cross-sections for estimates or determining questions of foundations.

Gaging stations were established at important points on the various canal routes and around the watershed of the water supply for the summit level. The observers were required to keep a careful record of the rain gage, river gage and thermometer, also to make gagings of streams with the current meters. Sediment observations were also conducted on the more important streams by lowering a sediment box and ascertaining the quantity of material moved in a certain **uniform** velocity in still water and plotting the results as **a curve**. The meter was then used with a boat that was anchored at points along the cross-section of a stream, if this was possible. It was sometimes necessary in large rivers in flood to rig a cable over the stream. On this was hung a car from which the observer used his meter. The results of the rain gage observations were plotted to give zones of rainfall, which were variously colored. These data and the river gaging operations were necessary in the very extended computations to ascertain the sufficiency of water for the lockage, and also the proper measures to be taken to regulate the floods.

The camps were usually sheds with a roof of palm leaves which were lapped similar to shingling; side walls were not necessary. Canvas tents were not a success, as they were soon ruined by the mildew of the damp climate of the rainy season. The beds were of a piece of canvas with poles through the side loops, and raised on crotched sticks. The kitchen arrangements were very simple; crotched sticks with a cross-bar were used to hang the kettle over the fire, or sometimes a rough fireplace of large stones took the place of this.

In the rainy season it was first the custom to attempt to dry wet clothes with Sibley stoves, but after several dry houses were burnt with their contents this was not in favor; it was found that no ill-effects were experienced from wet clothes, although it was not unalloyed pleasure to get out of warm blankets into cold wet clothes. In the evening, on returning from work, it was customary to take off wet clothes, have a bath and get into pyjamas. In mosquito-infested camps this was followed by getting under the mosquito bars as soon as possible after supper. It was sometimes necessary to do officework under mosquito bars.

The officework in the field was usually somewhat crudely done, merely to verify the accuracy of the work and its completeness. Duplicate copies of notes were made and sent to the division or chief engineer's office. At headquarters the fieldwork of the various parties was combined into large contour maps somewhat elaborately drawn. On these large contour maps the various projects were laid out and studied. A paper location would often be sent to an assistant engineer to be run out and verified. When all the data were in, estimates were made by taking cross-section notes from the map, plotting these with the classification of material obtained from the boring notes, and obtaining the yardage by the planimeter measurement. Maps were plotted and surveys adjusted by the method of latitudes and departures. Courses were generally referred to the true meridian in transit

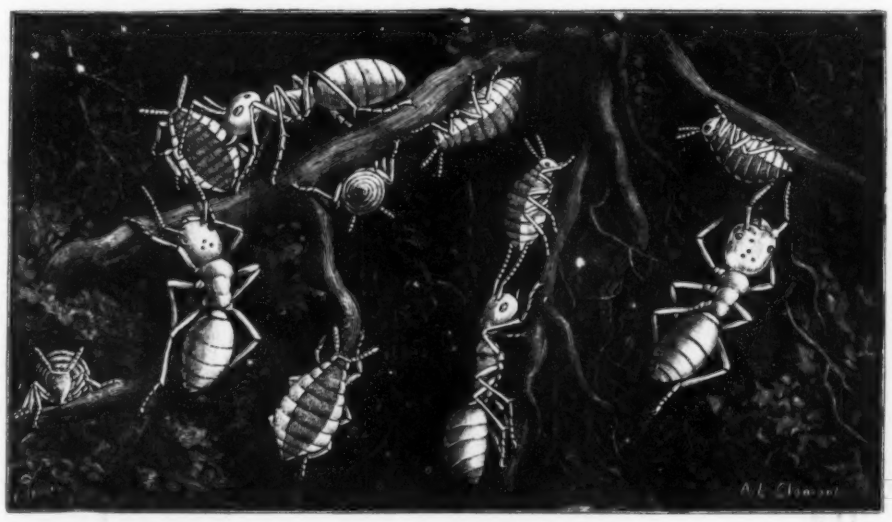


FIG. 4.—YELLOW ANTS (LASIUS FLAVUS) WITH ROOT LICE (HIGHLY MAGNIFIED).

work, checking this by the needle course. From star observations it was possible to get latitude co-ordinates for the maps. Longitude was obtained by carrying chronometers from Panama, which had been very accurately located by direct observation as a primary point by a French astronomical expedition.

By means of these map co-ordinates it was possible to combine the new work on small-scale maps with those of the coast survey and other expeditions. For this work the large maps were pantographed down; usually each set of maps was reduced one-fourth, although this was not strictly adhered to. In the Darien survey the field maps were 1-12,000, the general map of a route 1-60,000, and the general map of all the routes 1-300,000. The general map of the Panama route was made 1-100,000; the profile had a similar horizontal scale with a vertical scale 1-1,000. The general map of the Nicaragua route had a scale of 1-506,880, the sheets of general topography 1-57,600, and the detail topography 1-19,200; on these latter sheets were placed the boring records. Plans of structures were made 1-480, 1-960 or 1-100, as was necessary to show details.—The Architect and Contract Reporter.

HORSE BREEDING IN GERMANY AND FRANCE.

It is only during the last few years that special attention has been given to horse breeding in Germany. Careful inquiries into the subject show that the system so far followed does not meet the requirements of the army, or of the public generally. While in France, Belgium and Denmark horse breeding is said to pay farmers—especially small farmers—better than any other branch of industry, this is not the case in Germany, where many complaints are heard with regard to government rules, which are said to be adverse to a favorable development of horse breeding. In consequence, the importation of foreign-bred animals is continually increasing. In 1900 France exported 3,000 horses more than she imported, but Germany had to import 90,000 more than she exported. In view of these facts the German Foreign Office sent an expert to northern France to investigate horse breeding, and according to Consul Hughes, of Coburg, his report states that after the Franco-German war (1870-71) French horse breeding was nearly ruined, and in 1874 the French Chamber of Deputies had to grant money to gradually re-establish it, and the success now attained proves the wisdom of the act. In France 18,000,000 francs (£720,000)—of which the State alone contributes 2,355,570 francs (£94,220)—are spent every year in the improvement of horse breeding, while in Germany the government spends only a little more than 300,000 marks (£15,000), and gives a number of prizes for races. Among the causes which have contributed to the advancement of horse breeding in France is the fact that the whole management is under the charge of a specially appointed staff (in Germany it rests in the hands of one man). At the head of the French staff, under the supervision of the Minister of Agriculture, is the Director-General, with his office in Paris. Under him are six inspectors-general and other employés who purchase and care for the stallions for the State. Another useful institution is the stud school at Le Pin, where the training of employés is finished. The "breaking-in schools" (*écoles de dressage*) are of great assistance in the rearing of half-bred horses. The better class of coachmen and grooms often come from these schools. The skillful way in which the Paris hackney coachmen handle their horses, and make their way through the crowded streets—due less to the use of the whip than to attention—should, it is said, be credited to a great extent to the beneficial influences exercised by the "écoles de dressage." The forming of horse breeders' unions in Germany, a rational selection of stud horses, and some method of helping private persons or associations to keep the necessary stud of animals is advised. France had, in 1900, 3,087 stallions belonging to the State, and 7,480 to private persons; while in the kingdom of Prussia only 2,924 stallions belonged to the State, and 1,599 to private persons; and it must be remembered that Prussia is doing more than any other German State to improve the horse breeding establishments.—Journal of the Society of Arts.

DETERMINATE CAUSES OF THE FORMATION OF THE VISUAL ORGANS.

From the French of M. Antoine Pézon. Communication to the Académie des Sciences.

The differentiation of the visual organs appears simply due to the continuous action of two distinct factors: light and the pigmentary granules.

The determination of these organs depends on three classes of facts:

1. An eye always contains two fundamental parts; (1) the visual nervous cells connected with the nervous centers and constantly accompanied with pigmentary granules, to which the light communicates a vibrating movement; (2) a refracting apparatus consisting of a transparent portion of the integuments, in the form either of a mirror or of lenticular thickening, which may remain in continuity with the integuments (ocellus of the anthropoids, etc.) or be separated in the form of a lens (vertebrates, cephalopods, etc.)

2. Recent researches have demonstrated that the destruction of the sanguineous globules, the histolysis of the tissues during the larval period, etc., gives place to a production of pigmentary globules of variable color, in the composition of which chromatine appears to be often an important constituent. These granules are carried toward the surface of the body, either by their own movements or by migratory cells and they are finally expelled by epithelial desquamations. The granules of the skin and those of the eyes are fundamentally the same; and in many animals, particularly the frog, the pigment may be seen extending in uninterrupted trails from the deep sanguineous vessels to the charoid. The visual organ is therefore a point of concentration of the pigment, which is distributed almost uniformly in the epidermic cells.

3. The action of the light, and especially of the red and ultra violet rays, on the tissues cannot be doubted, since phototherapy is now applied to the treatment of certain affections (lupus, small-pox, measles), and the solar rays are employed for the attenuation of certain microbian cultures. On the protoplasm, light of average intensity determines in the first place a slight hypertrophy of the cell with increase of transparency, if it can be judged from the constant structure which the tissues of the surface of visual organs present. The rods and cones are in the same way the result of an hypertrophy caused by the light in the terminal protoplasmic prolongations of the visual cells.

The preliminaries settled, the formation of the visual organs may be thus conceived:

The pigmentary granules, having come to the periphery of the body, accumulate at certain preferable points of the epidermis from specific causes, mass of tissues in histolysis, gaps, exposed points, etc.

When these gatherings occur they determine, on account of their absorbing power, the impact of a more intense luminous pencil, a pencil which causes a special irritation of the tissues situated in its path.

At times the action of the light is limited to increasing the thickness of the cuticle (certain annelides) or of the chictine (ocellus of the anthropoids); in others, the more intense absorption of the radiations renders all the anterior part of the epidermic cells hyaline and refractive (syllis, etc.), and in species where the absorption is very intense and the vitality of the tissues very great, these respond to the luminous excitation by a more active proliferation and form in front of the pigmentary mass a transparent swelling which finally becomes isolated in the form of a lens (vertebrates, cephalopods, etc.).

In certain annelides, when the eye is constituted, with its crystalline, the neighboring epidermic cells multiply actively, make their way behind the cuticle and the lens and are transformed under the action of the light, into so many small refractive globules, which fuse together and add to the original crystalline, increasing its thickness.

When the refractive apparatus is constituted an image is necessarily produced in the interior of the eye, whose form and distinctness vary with the form of the refractive organ itself. It is thus that the apparatus produced by a mass of pigment and the refractive surface placed before it, comes secondarily to fill the function of vision.

To complete the visual organ it is sufficient that the luminous excitation should be received by the nervous cells, which transmit it in their turn to the sensorium. Such cells exist throughout the integument.

The phenomenon of vision appears therefore as simply the accumulation of pigmentary granules at certain points of the surface of the body and the absorbent power of these granules for luminous rays.

Thus is explained: (1) The position of the eyes in the most exposed regions, neural surface, anterior extremity, edges of the mantle (pectinids) extremity of the siphon (solens, tellina, etc.) bronchial cephalic filaments (certain annelides, etc.); (2) the position of the cephalic eyes is explained both by the presence of the light and by numerous pigmentary granules, which always engender nervous cells; the influence of heredity must be added, as well as the precocious transmission of the material pigment to the embryo; (3) the extraordinary number of the eyes (certain annelides, chitons, etc.) is connected with an abundant production of pigment; composite eyes (lepidopters, etc.) appear only during the nymphal period, when the tissues in histolysis have considerably increased the proportion of the pigmentary granules; (4) the disappearance, more or less complete, of the eyes in cavernicolous, fossorial and abyssal species and internal parasites which receive no light; (5) the absence of pigmentary masses explains the absence of eyes in forms very similar to others which live in the same conditions and can see as marine nematodes, nemertes, etc.

RECENT COAL LABOR STATISTICS.

The volume of mineral resources of the United States for the calendar year 1901, now in press, United States Geological Survey, presents some interesting statistics of the labor in the coal mines of the country.

From 1898 to 1901, inclusive, the statistics of coal production were as follows: In 1898, the average number of men employed was 401,221, and they averaged 190 working days during the year, producing 219,974,667, short tons of coal, valued at $205,000,850; in 1899, 410,365 men working 214 days produced 253,739,992 short tons, valued at $256,077,434; in 1900, 448,581 men working 212 days produced 269,682,827 short tons valued at $306,671,364; in 1901, 485,544 men working 216 days produced 293,298,516 short tons, valued at $348,910,469. In 1898, the average price of coal per ton was 95 cents; in 1899, it was $1.01; in 1900, it was $1.14; in 1901, it was $1.19.

According to the two great divisions of the coal industry, the bituminous and the anthracite, the statistics are as follows: In the bituminous coal industry in 1890, 192,204 men working 226 days produced 111,302,322 short tons, valued at $110,420,801, an average of 2.56 tons per man per day, and of 579 tons per man per year; in 1895, 239,962 men working 194 days produced 135,118,193 short tons, valued at $115,779,771, an average of 2.90 tons per man per day and of 563 tons per man per year; in 1900, 304,375 men in 234 days produced 212,314,912 short tons, valued at $220,913,513, or 2.98 tons per day and 697 tons per man per year; in 1901, 340,235 men in 225 days produced 225,826,849 short tons, valued at $236,406,449, or 2.94 tons per man per day and 664 tons per man per year. The average price of bituminous coal per short ton in 1890 was 99 cents; in 1895, 86 cents; in 1900, $1.04; in 1901, $1.05.

In the anthracite mines in 1890, the number of miners was 126,000, who in 200 days produced 46,468,641 short tons, valued at $66,383,772, the average production being 1.85 tons per man per day and 369 tons per man per year; in 1895, 142,917 men produced in 196 days 57,999,337 short tons, valued at $82,019,272, an average of 2.07 short tons per man per day and of 406 tons per man per year; in 1900, 144,206 men working 166 days produced 57,367,915 short tons, valued at $85,757,851, or 2.40 short tons per man per day and 398 tons per man per year; in 1901, 145,309 men worked 196 days and produced 67,471,667 short tons, valued at $112,504,020, an average production of 2.36 short tons per man per day and of 464 tons per man per year. The average price per short ton of anthracite coal in 1890 was $1.43; in 1895 it was $1.41; in 1900 it was $1.49, and in 1901 it was $1.67.

In the last twelve years the number of workers in the anthracite mines has increased from 126,000 in 1890 to 145,309 in 1901, or over 15 per cent. During the same period the number of men in the bituminous mines has increased from 192,204 to 340,235, or a little over 77 per cent.

The statistics of accidents in the mines in the calendar year 1901, already published in part, show that 1,467 men were killed, 3,643 men were injured and that 188,668 tons of coal were mined for each life lost. In the bituminous mines of the country 954 men were killed and 2,400 were injured, in a total of 340,235 men at work; in the anthracite mines 513 men were killed and 1,234 were injured, in a total of 145,309 at work.

The statistics for Pennsylvania alone show 301 men killed, 656 men injured, and an average of 273,288 short tons of coal mined for each life lost in the bituminous mines; and 513 men killed, 1,243 men injured, and an average of 131,524 short tons of coal mined for each life lost in the anthracite mines. It is interesting to note that in Pennsylvania the number of short tons of bituminous coal mined per life lost was a little more than double the number of short tons of coal mined per life lost in the anthracite mines.

THE MALADIES OF WINES.

Wines, like human beings, pass through youth, maturity and old age. Like them, too, they are subject to diseases. The cause of these latter is either deficiency in body or the action of ferments. One or the other of these produces sour wine, bitter wine, musty wine, ropiness or turbidity.

Sour wine has the taste of vinegar. This trouble occurs when wine has been allowed to remain too long in the fermenting tun. The surface ferment becomes acidified through contact with the air, from which it is no longer separated by the carbonic acid, the production of which has ceased, and the acid ferment communicates its acidity to the wine. The wine would become still more sour were the casks left unfilled and the bunghole open. This malady is explained by the oxidation of the alcohol by the oxygen of the air and its conversion into acetic acid. Such acidification may be represented by the formula:

$$C_2H_6O_2 + H_2O_2 \text{ (alcohol)} + C_2H_4O_2 \text{ (acetic acid)}.$$

Pasteur has shown that this property of transporting air to alcohol and changing it into acetic acid is due to a vegetable ferment. The remedy will therefore consist in freeing the wine from such ferment. This may be done by fining followed by racking off, when the ferment will remain in the lees.

Wine becomes bitter only when it is of weak body, and is wanting in alcohol, tannin and tartaric acid. The bitterness may be reduced in two ways, viz.: (1) by adding 1 liter of brandy, 10 grammes of tannin and 50 of tartaric acid to each hectoliter of wine; and (2) by pouring the bitter wine into a cask containing a few liters of a newer wine along with its lees. The latter gives rise to a second fermentation, which, rejuvenating the wine, so to speak, removes its bitterness.

Wine becomes musty from being inclosed in mouldy casks. The taste of such wine is due to ethers that may be got rid of by mixing half a liter of good olive oil with the liquid. The oil absorbs the ethers and rises to the surface and is separated from the wine by racking the latter off.

Ropiness is a malady of white wines which contain little tannin. The surface becomes covered with those kinds of beads characteristic of the presence of grease in a bouillon. The trouble may be remedied by the addition of from 15 to 30 grammes of tannin to the hectoliter.

Turbidity is a malady that affects the color of wines. In a wine in which this trouble occurs we observe in the first place a film of iridescent color form upon the surface, and then the wine becomes turbid, and the color gradually deposits upon the bottom. Two kinds of this malady occur—the brown and the blue. In the former the turbid wine has the color of chocolate, and in the latter the color is of a blackish blue.

The former is prevented by two treatments, viz., by heating the wine to 65 deg. in a Pasteur apparatus, or by adding sulphurous anhydride (sulphurous acid). In the latter case from 2 to 10 grammes of bisulphide of potassium to the hectoliter are placed in a linen bag and introduced into the cask and allowed to remain therein until the bisulphide is dissolved. This salt disengages half of its weight of sulphurous acid, which impregnates the wine and renders harmless therein the ferment to which the turbidity is due.

This ferment, which is called oxydase, produces an oxidation of the coloring matter of the wine, and this, after becoming oxidized, becomes insoluble and falls to the bottom of the receptacle in which the liquid is contained. Such oxidation does not take place in the cask, but only after the wine has been racked off and exposed to the air. Nor will it take place if the ferment has been previously destroyed, either by heating the wine or by the disengagement of sulphurous acid from bisulphide of potassium. So, before racking off a wine that is suspected of being affected with this trouble, it is well to test it. To do this a test-glass filled with wine is left exposed to the air for several days. If the wine presents the symptoms noted above—the formation in the first place of an iridescent film on the surface and then a turbidity and a subsidence of the coloring matter—it may be known that the wine is affected; and in such a case care must be taken not to rack it off before having treated it. But, even after this has been done, it is necessary to make sure by the same means that the treatment has been adequate.

Sometimes a sulphured wick is employed for obtaining the sulphurous acid for preventing the malady. In this case a little of the wine in drawn off through the faucet, and, in the vacant space thus formed, from 2 to 2.5 grammes of a sulphured wick is burned. Care must be taken not to allow any pieces of the carbonized wick to fall into the wine, since these would give

the latter a bad taste. The wine drawn off before the operation is put back into the cask and the bung is then driven in.

In such treatments too large quantities of bisulphide of potassium or sulphured wick should not be employed. An excess of sulphurous acid would discolor the wine. The trouble under consideration is preventable but not curable. After the color has once become insoluble and separated from the wine it cannot be rendered soluble again.

The other variety of the malady is remedied by the addition of from 10 to 20 grammes tartaric acid to the hectoliter. This salt is dissolved in tepid water and poured into the wine, and some egg albumen is then added and the whole is violently beaten. As soon as the wine is clarified it is decanted into a very clean receptacle.—Cosmos.

TRADE SUGGESTIONS FROM UNITED STATES CONSULS.

Trade Conditions in South Africa.—Consul-General H. Clay Evans sends from London, August 25, 1902, newspaper clippings in regard to the competition for trade in South Africa, which reads in part:

Before the war there were 6,000 stamps clanging along the reef, crushing the gold-laden ore. Ere long, we are assured from the Chamber of Mines—the inner circle of ownership—there will be 17,000 of these ponderous iron heels pounding away between Randfontein and Bocksburg, and the ratio of well-being is to rise in strict proportion. If, for argument's sake, a 6,000-stamp industry signified £3,000,000 ($14,599,000) worth of imports to support the dependent population, we shall want nearly £9,000,000 ($43,798,000) worth of goods of all sorts when the new batteries are in full swing. Who is going to annex this tremendous increase in trade?

There is only one answer: Great Britain. It did not need a special mission to settle the point, for this very simple reason if for no other. Not a single "house" at home but has an agent or representative on the spot. The manufacturer in Great Britain knows better than his rival in any part of the world what are the conditions and requirements of South Africa, from Cape Point to the Zambezi, and he can do all the trade he wants—if he wishes.

The only serious competition will come from America. It does not necessarily follow that the machinists of Lancashire and the Black Country should throw up the sponge before the first round. They can learn many lessons from the enterprising American and creep into his footsteps.

One reason why the costly mine machinery has, in late years, come largely from the United States is this: The kind of machine used on the Rand is to all intents the same as has been used in the silver mines of Nevada for many years, and competition there evolved the fittest, so that when these fields began to develop there was the plant ready for shipment in New York; but, in spite of low ocean freights, the American has been gradually pushed back until we find—what? That Messrs. Frazer & Chalmers, the one-time almost monopolists of mine outfits, have started huge works at Erith for the production of these heavy fabrics. Thus the trade has largely migrated to England, and solely because British materials cannot be equaled in the world.

No mine ever starts unless the ground has been tested by a "bore hole," drilled, it may be, through a couple of thousand feet of rock in search of the precious reef. The drill, which is a disk studded with rough diamonds, eats its way downward with a rotary motion, and in its hollow interior lodges the "core," a slender cylinder that is now and again examined for traces of banket, or gold-bearing rock. Now, why is it that the British firms cannot make headway with their drills against the Americans?

There is not a British drill at work on the Rand; they are heavy, cumbrous, slow. The American machine is light, compact, easily worked. Of course, diamond drills have been in use so long in America that the type has been perfected, but experts tell me there is no earthly reason why the same or a better machine should not be turned out from a Lancashire or Staffordshire workshop. As drills cost from £1,000 to £5,000 ($4,860 to $24,300), according to the length of rods, there is money waiting to be earned.

In the early days of the Rand, the supply of picks, shovels, light trolleys, and rails used underground to carry the hewn rock to the shaft foot was almost entirely in the hands of Americans. Sheffield and Birmingham have captured this market and can hold it against all comers on downright merit. For the same reason, Tangye's and "Lancashire" boilers are favorites along the reef. Also, where once the Americans supplied three-fourths of the compressed air-drills used against the "face" below ground, the "Climax," made in Cornwall, now stands in the first place. On winding engines and air compressors almost every name plate bears the address of some British firm.

The Duchy also has perseveringly set itself to work against Germany in the making of safety or time fuses, of which large quantities are used in blasting the banket rock. Germany not so long ago had this supply as a monopoly, but by sheer merit the fuses made at Bickford, Cornwall, have regained a very large portion of the lost business.

No one need be surprised to learn that America walks off with the lion's share of trade in food supplies. The enormous grain stores of the West, the abattoirs of Chicago, and the colossal tinning depots of that country send their surplus here on terms of cost and freight that render British competition hopeless even if Great Britain were a producing center instead of a world's entrepôt.

. . . . . .

British trade is in an exceedingly strong position in South Africa, and in those lines in which she may naturally expect to share, Great Britain was never better placed.

Let the British manufacturer bear these figures in mind: Of the whole Transvaal import trade the Old Country does 75 per cent, America 15 per cent, and all other countries in the world divide 10 per cent among them.

America comes in with goods that nature and experience have fitted her to supply; the other countries owe what slender foothold they have in this market to ingenuity, tact and cheapness. When Lancashire and Yorkshire, Staffordshire and South Wales agree to work twelve hours a day for 60 per cent less than current wages, there will be only two competitors for custom here—John Bull and his American cousin. But is the sacrifice called for?

GERMAN TRADE.

Germany—cheap-labored, long-houred Germany—scizes perhaps 6 per cent of the business, not more. Is it worth explaining how she got even so much, and why she ought to be deprived even of that share in the future?

There was a time before 1899 when the rulers at Pretoria strove by every means, open and underground, to foster trade with Germany. . . . It was an artificial growth, fertilized by orders given with a special object from Pretoria and Johannesburg; its roots had no grip of the soil, and they have withered at once now the cultivator has gone and left them to the influence of crowding competition and fair play.

Ironware.—In enameled ironware, so vastly used in this country, where crockery cannot be trusted to stand rough handling, Germany once held the field. Then the United States came in with a better article and knocked her out. Then the Staffordshire and Warwickshire maker introduced one better and heavier, and now, as the manager of Holt & Holt told me, buyers find more value in the 3s. (73 cents) article (British) than in the half crown (60 cents) American.

Crockery.—Makers in the potteries should put their heads together and create a cheap and good-looking china tea or coffee set, because that is the only line in earthenware in which the foreigner (German and Austrian) "has a show." Neatly packed in a gaudy box, these cups and saucers have a charm for the Dutch vrow in town on a buying expedition. The familiar "blue-lined" dinner ware and "white and gold" crockery is all British, and it has steadily improved its position for ten years past.

Clothing.—There is an illimitable market in the Transvaal and the Orange River Colony for men's cheap ready-made clothing. The Boer does not keep a tailor; all his garments are bought "off the shelf" at the country storekeeper's.

This is where German cheap labor comes in again. Trousers have been shown to me that cost in Hamburg f. o. b. 12s. 6d. to 14s. 6d ($3.03 to $3.52) per dozen pairs complete. Add, say, 30 per cent, and they cost here 1s. 4d. to 1s. 10d. (32 to 44 cents) per pair, and sell at anything from 7s. 6d. ($1.82) upward.

Blankets.—Belgium has been having a cut-in fairly successful for Kaffir blankets—the native's bed and overcoat and general utility wrap. The article most in favor is two-faced—smooth on one side and having a kind of nap on the other, not unlike the moleskins made about Rochdale.

For ordinary blankets, nobody is in the same street with the British manufacturer. Shawls (and every colored woman in the subcontinent is swathed in a shawl) are eaten into by the Germans, because they send out an article more showy in color and a trifle lower in price. Todmorden mill owners should take the hint.

Furniture and Vehicles.—We must have furniture, even in a new country, and all but 5 per cent of it is imported. Whence comes it? Go over any decent sort of house in Johannesburg and you find the drawing-room and dining-room suites come from London, the beadsteads from Birmingham, the carpets from Kidderminster, the linoleum from Scotland, the electric-light fittings from London, the cheap bent-wood chairs from Austria, the stoves from America, the cutlery from Sheffield, and the glass and earthen ware from Staffordshire.

The United States are untouchable in office furniture, especially the invaluable roll-top desk, because they have the forests of oak and the factories laid out for this express work. But what is the British carriage builder about that he lets the vehicle trade stay almost entirely in American hands?

Of course, the millionaire has his landau and dog-cart from Long Acre, but these are but drops in the ocean. Every farmer has his Cape cart—that heavy but everlasting ship of the veldt. He may have a "spider" or light-framed buggy; he may have two of each. The hansom of South Africa is a species of victoria, carrying four passengers, and with a falling hood. Nearly all these (and particularly the buggies) come from America. Again, why? British firms angle for orders for half a dozen locomotives with great perseverance. What about the thousands of conveyances needed in every part of a country a thousand miles square?

Traveling in Tripoli: Flour Market.—For the benefit of correspondents who have addressed me since the publication of a recent report upon Tripoli,* I have obtained the following information: Travelers desiring to penetrate into the interior must first obtain a special permit from Constantinople, through the legation. This is not so easily done as may be imagined. Six or seven years ago, Mr. Herbert Weld-Blundell, the English traveler, secured a special permit, after seeking it for two years, and was then allowed to explore the ruins of Cyrene to the east of Benghazi. The British Museum, aided by the British Foreign Office and the embassy at Constantinople, tried for two or three years to obtain a similar permit for Mr. Edward Dodson, a well-known traveler and hunter. This was finally accomplished and, in April of 1901, Mr. Dodson was fitted out with men, horses, camels, and provisions by William F. Riley, of Tripoli. He left for Murzuk in Fezzan, and returned via Benghazi early the following September. The object of his journey was to make a collection of mammals for the British Museum.

There is always more or less risk involved in traveling. Mr. Dodson was accompanied by two Zeptias, sent by the governor-general, his own assistant (Mr. Drake), a head Arab, and five others. They narrowly escaped being ambushed by a wandering tribe. This danger is more remote at Cyrene, as the authority of the government is acknowledged along the coast. However, it is always well to be provided with good, light sporting rifles. Two Italian gentlemen, an engineer and a journalist, are now in Tripoli, having secured the requisite traveling permit, and intend departing for Ghadamés shortly. Reliable Arabs can always be found in Tripoli City. Mr. Riley, above mentioned, would doubtless be the best authority to consult for practical information.

French and English are of little use in interior Tripoli; Italian is occasionally serviceable. Mr. Dodson overcame this difficulty, so Mr. Riley says, by hiring a cook who acted also as interpreter.

Flour.—Five grades of flour are sold in Tripoli at the following prices per 100 kilogrammes, or 220 pounds—$2.12, $2.50, $3.28, $3.76, $4.14. The low-grade flour is most in demand for use by the Arabs. These prices are c. i. f. Tripoli; merchandise packed in bags of 50 or 100 kilogrammes, weight of bags being charged for as flour. The terms are: Thirty days, with 1 per cent discount, or sixty days, without discount, at buyer's option. The duty upon flour and all classes of merchandise from whatever country is 8 per cent ad valorem.

I know of no more satisfactory merchant to address than William F. Riley, who is an importer and exporter. He may be written to in English. Other firms named in the directory are:

J. & B. Arbib & Co., silks, plumes, skins; Borges da Silva, Galea Federico, M. J. Hassan, Is. de Labi, Levy Frères, Arthur Ricard, M. Sahal, Scialmon Tammam & Co., Scioma & Co.—Robert P. Skinner, Consul-General at Marseilles.

Hop Crop in Europe for 1902.—The city of Bamberg being recognized as the second in importance in Germany as headquarters for hops (the first being Nuremberg), I have paid considerable attention to the culture of and the trade in this important product. At this time of the year, speculation is ripe as to the result of the crops all over the world, and it may be of interest to American consumers of this article to know what the conditions are in this immediate neighborhood.

From careful interviews with hop planters and hop dealers, I find that the crop in Bavaria is in excellent condition. The weather which, on account of low temperature and more than plentiful rains, has been rather unfavorable to nearly all other crops, has been highly beneficial to the growth of the hop plant, the only visible drawback being a delay of more than two weeks in the ripening of the burr, so that this season's crop in Bavaria will be gathered later than it has been for thirty years. Otherwise, the plants are in excellent condition; they are full of ripening fruit; there is hardly a yellow leaf on the stalks, and no insects or flies have appeared to damage the plants. The weather continuing favorable, the crops in Bavaria will be very fine in quality as well as very large in quantity. The system of raising hops on wire has proved very successful, more so than the old system with poles.

Conditions in Wurttemberg, Baden, Alsace-Lorraine, and other places are reported to be nearly as good as those existing here. In Bohemia, too, the coming crop promises to be of excellent quality, and the output will be fairly large; it is at present computed at nearly two-thirds of last year's enormous crop.

Reports from other hop-growing countries indicate that the crops which are likely to be gathered, are not as good. The crop in England is said to be only one-half that of last year.

The crop in the United States is also reported short; but the Continent can easily supply any deficiency at moderate prices.

The table below shows an estimate of the hop crop in the most important hop-growing countries for this year, compared with that of 1901. I obtained the same from excellent authority.

ESTIMATE OF THE HOP CROP FOR 1902 AND COMPARISON WITH LAST YEAR'S CROP.

		1902.	1901.
Germany:			
Bavaria	cwts..	250,000	98,000
Wurtemberg	cwts..	65,000	55,000
Baden	cwts..	50,000	24,000
Alsace-Lorraine	cwts..	80,000	60,000
Prussia and Altmark	cwts..	43,000	22,000
Total	cwts..	488,000	259,000
Austria-Hungary:			
Bohemia	cwts..	200,000	281,000
Moravia and Galicia	cwts..	27,000	30,000
Steyermark	cwts..	17,000	16,000
Hungary	cwts..	6,000	6,000
Total	cwts..	250,000	333,000
England	cwts..	360,000	650,000
United States	bales..	215,000	187,000

—W. Mardel, Commercial Agent at Bamberg.

INDEX TO ADVANCE SHEETS OF CONSULAR REPORTS.

No. 1462, October 6.—Trade Conditions in Japan.

No. 1463, October 7.—Uralite; New Fireproof Material—French Sugar Beauties—Strikes of Coal Miners in France—A New Covering for Roads—Exposition of Commerce and Hygiene at Athens.

No. 1464, October 9.—New French Enterprises—French Wine Harvest and Sales—* Improvement of the Port of Algiers—* Exhibit of Alcohol Appliances at Lima.

No. 1465, October 10.—Labor Law in Nicaragua—*Importation of Cattle into Cuba—*Price of Beef and Scarcity of Cattle in Belgium—Street-cleaning Apparatus at Düsseldorf Exposition—The Anglo-Belgian Telephone—* New Pepper from Africa—* Bulawayo-Cape Town Railway Service.

No. 1466, October 11.—German Process and Machinery for Briquette Manufacture.

The Reports marked with an asterisk (*) will be published in the SCIENTIFIC AMERICAN SUPPLEMENT. Interested parties can obtain the other Reports by application to Bureau of Foreign Commerce, Department of State, Washington, D. C., and we suggest immediate application before the supply is exhausted.

* Advance Sheets No. 1397 (July 21, 1902.); Consular Reports No. 264 (September, 1902.)

TRADE NOTES AND RECIPES.

Carpet Soap.—A specimen of an American carpet soap (says The American Soap Journal) exported to Europe found its way to the municipal laboratory of the city of Breslau, and, after examination, received the following verdict:

"This soap is to be used by making a stiff lather from a rather concentrated solution of the soap; this is then applied to the carpet and left to dry. After the drying the soap has become brittle, and can be beaten out, the single particles so removed taking the dirt along.

"The analytical data were as follows: Water, 9.67 per cent; residue on drying, 90.33 per cent; ash, 22.2 per cent (in the same 19.3 per cent sodium carbonate determined by titration). The separated fatty acids showed: Melting point, 43-44 deg. C.; congealing point, 40-41 deg. C.; acid number, 214.15; iodine number, 38.0.

"Accordingly this carpet soap is nothing more or less than an honest tallow-soda soap. Its effect depends simply on the circumstances that with such soap a stiff lather is only obtained with concentrated solutions, which then remains and dries; soaps made with palm oil and other exotic fats, on the other hand, yield a strong lather with thin solutions, but this lather subsides again rapidly. On the same fact, by the way, is based the secret of good shaving soaps."

Certain Oils can be purified by ordinary methods, but there are others that resist all the known processes. This problem has been solved by M. Douillet in the following way: The method consists in a combination of three agents, alcohol, steam and bone black, with or without mixture of magnesium carbonate, which are made to act successively under suitable conditions of temperature. Thus, the vapor of alcohol is passed through a bath of oil, which is to be purified; the vapor is charged with odorous principles; but this operation is not sufficient for obtaining the decoloration and purification of the oil. But if, after the passage of the alcohol, a current of highly heated steam is passed through the oil the vapor draws off the impurities which remain and deoxidizes the oil, which owes its rancidity to partial oxidation. After the action of the steam, the purified oil is flowed off and passed through a filter with bone black and magnesium carbonate.—La Revue des Produits Chimiques.

Liquid Antiseptic Soap.—A formula for a liquid antiseptic soap is given by M. I. Wilbert, apothecary at the German hospital, Philadelphia (American Journal of Pharmacy), which is said to possess all the antiseptic and detergent value of the higher-priced proprietary article. It is as follows:

Cottonseed oil	300 Cc.
Alcohol	300 Cc.
Water	325 Cc.
Sodium hydrate	45 Gm.
Potassium carbonate	10 Gm.
Ether	15 Cc.
Carbolic acid	25 Cc.

To the oil contained in a bottle of sufficient size add 100 Cc. water and 200 Cc. alcohol; add the sodium hydrate and shake or stir occasionally until saponification has taken place, then add the remaining portions of alcohol and the potassium carbonate dissolved in the water; lastly, add the carbolic acid and the ether, and mix or shake well. Keep in well-corked vials to prevent evaporation of the alcohol. It is advisable to keep the soap at a temperature of not below 10 deg. or 12 deg. C., so as to prevent solidification, although this does no permanent harm, as the soap will liquefy again if placed in a warm place for an hour or more. This soap is a light yellow liquid with an ethereal color and alkaline reaction. A few drops poured in the palm of the hand after previous wetting will give with a very slight rubbing a copious lather that stands up well for a considerable length of time.

A modification of this formula, adapted to toilet use, is had by omitting the ether and carbolic acid and substituting for them a few drops of an essential oil, such as rose geranium or bergamot; this soap is recommended as a satisfactory substitute for cake toilet soaps, and for use in shaving, shampooing, etc.; it is also said to be excellent for use in cleansing prescription utensils.

A Varnish is composed of amber and (preferably) of pure linseed oil not boiled. These substances are submitted without shaking to a temperature between 37 deg. and 400 deg. C. An iron receptacle with porcelain lining is employed in which the amber is placed, either in pieces or finely divided, with the necessary quantity of pure unboiled linseed oil. The ingredients are introduced cold, and then submitted without shaking to heat. At 278 deg. C. a froth is formed, and at this temperature the amber commences to melt. The heat is gradually raised to 376 deg. C., varying between this temperature and 400 deg. C., resulting in the complete dissolving of the amber. The quantities employed are 928 grammes of amber with 900 grammes of oil, but the quantity of oil can be modified to 175 grammes, more or less; and notwithstanding this, a useful product obtained. Afterward, the temperature is lowered to 154 deg. C. and the mixture diluted by adding oil of turpentine, and at the same time shaking it in order to incorporate the turpentine thoroughly with the amber and oil. The deposit consists only of foreign substances, such as dust and sand; the varnish remains constantly the same and does not thicken, and deposits nothing but the foreign substances mentioned. This varnish resists the influence of salt water and is insensible to the strongest ammonia. It also successfully resists numerous acids. The varnish made in this way possesses remarkable fluidity, and is capable of receiving a beautiful polish from a small number of layers.—La Revue des Produits Chimiques.

Ordinary Dynamite is made up of 75 per cent nitroglycerine, 25 per cent infusorial earth; dualine contains 80 per cent nitro-glycerine, 20 per cent nitrocellulose; rend-rock has 40 per cent nitro-glycerine, 40 per cent nitrate of potash, 13 per cent cellulose, 7 per cent paraffine; giant powder, 36 per cent nitroglycerine, 48 per cent nitrate of potash, 8 per cent sulphur, 8 per cent resin or charcoal.—Mining and Scientific Press.

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